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REPORT  
of  
THE ARMY AIR FORCES BOARD

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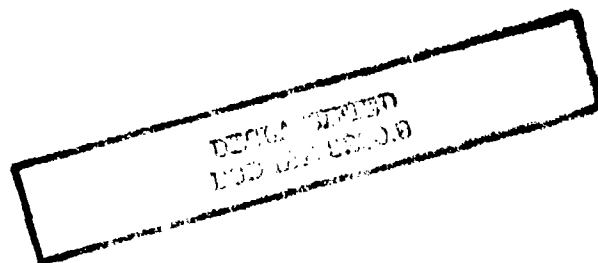


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AAFSAT, ORLANDO, FLORIDA

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SUBJECT



HANDBOOK FOR BOMBARDIERS

PROJECT No. (T-1) 14 - 2837

DATE 8 February 1944

COPY No. 16

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19 November 1943

**SUBJECT:** Handbook for Bombardiers, Army Air Forces Board Project No.  
(T-1) 14.

**TO :** Commanding General, Army Air Forces Tactical Center, Orlando,  
Florida.

1. It is requested that the Army Air Forces School of Applied Tactics undertake as a project the preparation of a draft of a handbook for bombardiers.

2. Copy of letter from Headquarters, Army Air Forces, Washington, D.C. dated 8 November 1943, directing the preparation of a handbook for bombardiers, and copies of TM 1-252 and a Bombardier's Data Book from the Sixth Air Force are inclosed.

3. It is desired that the final report be completed and reach this office by 11 December 1943.

4. The final report on this project will be prepared in seventeen (17) copies.

For the Army Air Forces Board:

**E.L. HUBANK**  
Brigadier General, U.S. Army  
Executive Director.

3 Incls:

Incl. 1 - cy of ltr fm  
Hqs. Wash. dtd  
16 Nov 43.

Incl. 2 - Cy of TM 1-252

Incl. 3 - Bombardiers Data Book.

Accession For	
NEWS - 1943	<input type="checkbox"/>
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Just	<input type="checkbox"/>

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THE ARMY AIR FORCES BOARD  
Orlando, Florida

"HANDBOOK FOR BOMBARDIERS"

Army Air Forces Board Project No. (T-1) 14

1. OBJECT: The object of this study is to develop a handbook for bombardiers containing pertinent data for combat bombing.

2. INTRODUCTION: This study was directed by Headquarters, Army Air Forces, Washington, D. C. by letter dated 16 November, 1943. The Army Air Forces School of Applied Tactics was requested to prepare a handbook for bombardiers by letter from the Executive Director of the Army Air Forces Board to the Commanding General, Army Air Forces Tactical Center, Orlando, Florida, under date of 19 November, 1943. The enclosed "Handbook for Bombardiers" was forwarded from the Armament Section, Strategic Bombardment Division, Combat Operations Department, Army Air Forces School of Applied Tactics, AAFTAC, Orlando, Florida, 1 February, 1944, and received by the Army Air Forces Board on the same date.

3. CONCLUSIONS: It is concluded that the proposed "Handbook for Bombardiers" is an excellent study that meets the requirements for such a handbook.

4. RECOMMENDATIONS: It is recommended that the enclosed "Handbook for Bombardiers" be adopted and published in the form of a loose-leaf notebook. Distribution recommended is one per bombardier, U. S. Army Air Forces, to be included in the regular bombardier's kit.

5. DISCUSSION: Information upon the Sperry S-1 Bombsight is not now available at Army Air Forces School of Applied Tactics. When such information becomes available, a section on this bombsight will be prepared and forwarded to become a part of the "Handbook for Bombardiers."

6. INCLOSURES:

- a. Directive - ltr. dtd. 16 Nov. 1943 from Hq. AAF, Washington 25, D.C.
- b. Handbook for Bombardiers (M-Series Bombsight).

PREPARED BY:

Maj. E. F. Hoover, Jr., Tactics Division, AAF Board.

CONCURRED IN BY:

Col. H. G. Montgomery, Jr., Chief Tactics Division, AAF Board.  
Col. Cecil E. Combs, Executive, AAF Board.

APPROVED:

For the Army Air Forces Board:

*E. L. Eubank*  
E. L. EUBANK,  
Brigadier General, U.S. Army,  
Executive Director.

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WAR DEPARTMENT  
HEADQUARTERS OF THE ARMY AIR FORCES  
WASHINGTON

November 16, 1943

SUBJECT: Handbook for Bombardiers.

AFRDB

TO: Executive Director, Army Air Forces Board  
Orlando, Florida.

1. It is desired that your office prepare a draft of a handbook for bombardiers containing pertinent data for combat bombing. This book is not to duplicate material covered in the recently revised edition of Training Manual TM 1-252 (Bombing Aids).

2. It is further desired that any reference to bomb sight maintenance, auto pilot maintenance or armament maintenance be kept to a minimum, including only those things necessary for simple field maintenance that could be performed by the combat bombardier.

3. The final over-all dimensions and form of the subject handbook are to be determined at a later date. The tentative plan is for a book 5-1/2 by 8-1/2" in size of a loose-leaf type, so future changes and additions may be easily made. Your comments on the type and size are desired.

4. This booklet is to be distributed to all bombardiers as a standard part of the regular bombardier's kit.

5. Copies of TM 1-252 and a bombardier's data book from the Sixth Air Force are forwarded for your information.

6. In order to expedite the publication and release of the booklet to combat air forces, request that this project be completed by 15 December.

By command of General ARNOLD:

/s/ O. P. Weyland  
O. P. WEYLAND  
Brig. Gen., U.S.A.  
Acting Deputy Asst Chief of  
Air Staff Operations, Commit-  
ments and Requirements.

2 Incls:  
as listed

Inclosure No. 1

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HANDBOOK FOR BOMBARDIERS

(M-Series Bombsight)

Compiled By

ARMAMENT SECTION,  
STRATEGIC BOMBARDMENT DIVISION  
COMBAT OPERATIONS DEPARTMENT  
AAF SCHOOL OF APPLIED TACTICS, ORLANDO, FLORIDA

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*Incl: 2*

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# INTRODUCTION:

This handbook is intended primarily to give the bombardier a quick and ready reference to procedure used in the field. For this reason the information compiled has been given in a highly briefed style, wherever the content permits the use of this form of presentation. The handbook should not be considered as a text, nor is it comprehensive. Changes and additions may be made from time to time as the needs arise.

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CHAPTER ONE

FUNDAMENTALS OF BOMBING

SECTION I

DEFINITIONS

1. ALTITUDE. In bombing, altitude refers to the absolute altitude or the actual distance of the ship above the target.
2. HEADING. The direction in which an aircraft is pointed regardless of its path over the ground.
3. TRACK. The vertical projection on the ground of the aircraft's path.
4. ACTUAL RANGE. The horizontal travel of a bomb, from release to impact measured on a level with the point of impact.
5. DROPPING ANGLE. (Sometimes called range angle.) That angle at the airplane between the vertical and the target which subtends the actual range.
6. SIGHTING ANGLE. The angle between the line of sight and the vertical at any moment is the sighting angle at that moment. The sighting angle and dropping angle are the same only at the instant of release.
7. CIAS. Calibrated indicated air speed. The indicated reading corrected for instrumental and installation errors.
8. TAS. True air speed. The actual speed of an aircraft relative to the air. It is determined, using standard navigation computers, by correcting the calibrated air speed for density, using temperature and pressure altitude corrections. It is used for finding the velocity of the wind, the ground speed, and the correct trail setting.
9. SPEED OF CLOSING. The velocity of approach of an aircraft relative

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to the target.

10. TRAIL. The horizontal distance in direction reverse to the aircraft's heading between the point vertically under the aircraft at the instant of impact and the point of impact.

11. TRAIL ANGLE. The angle at which the impact is observed back of the vertical under the aircraft, or the angle back of the plane which subtends the trail.

12. CROSS TRAIL. The distance from the track, right or left, that the bomb falls, due to the fact that trail is in the direction reverse to the heading and not in reverse to the track.

13. RANGE COMPONENT OF CROSS TRAIL. The distance that the bomb hits over the target due to the fact that the bomb sight allows for trail in reverse to the track and not in reverse to the heading as it occurs.

14. DRIFT ANGLE. The angle, measured in degrees, between the heading and the track.

15. BALLISTIC COEFFICIENT. A number assigned to a bomb according to its size, shape, and weight which is a measure of its air resistance of stream lining. It is determined by proving ground test. The number is based on an arbitrary standard of one.

16. TERMINAL VELOCITY. That rate of fall at which the air resistance is equal to the bomb weight and beyond which no further increase in velocity can occur. Terminal velocity may be used as an expression of the ballistic characteristics of a bomb.

17. TIME OF FALL. Total time it takes bomb to travel from point of release

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to point of impact.

(Note: Time of Fall is a function of the ballistic coefficient and is set in the M type bombsight through a quantity known as disc speed.)

18. TRAJECTORY. The parabolic curved path traced by a bomb from point of release to point of impact.

19. TANGENT. =  $\frac{\text{Opposite}}{\text{Adjacent}}$

20. COTANGENT. =  $\frac{\text{Adjacent}}{\text{Opposite}}$

21. SINE. =  $\frac{\text{Opposite}}{\text{Hypotenuse}}$

22. COSINE. =  $\frac{\text{Adjacent}}{\text{Hypotenuse}}$

As the tangent increases so does the angle.

23. VELOCITY. The rate of change of place or position.

24. ACCELERATION. The rate of change of velocity.

## SECTION II

### CALCULATIONS

#### 1. SYMBOLS.

a. D - distance.

b. t - time.

c. A - acceleration.

d. T - trail.

e. DA - dropping angle.

f. DS - disc speed.

g. GS - ground speed.

h. ATF - actual time of fall.

i. VTF - vacuum time of fall.

j. WR - whole range.

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- k. AR - actual range.
- l. OT - cross-trail.
- m. RCCT - range component cross-trail.
- n. V - velocity.

2. FORMULAE.

- a.  $D = Vt$
- b.  $D = \frac{1}{2} at$
- c.  $VTF = \frac{1}{2} 1/\text{Alt.}$
- d.  $WR = ATF \times GS$
- e.  $AR = WR - T$
- f.  $AR = (ATF \times GS) - T$
- g.  $\text{Tan dropping angle} = \frac{AR}{\text{Alt.}}$
- h.  $AR \text{ in mils} = \text{Tan dropping angle} \times 1,000.$
- i.  $\text{Trail in Feet} = \text{Trail in mils} \times \frac{\text{Alt}}{1000}$
- j.  $CT = T \sin \text{drift angle.}$
- k.  $RCCT = T (1 - \cos \text{drift angle}).$
- l.  $\text{Disc speed} = \frac{5,300}{ATF}$
- m. Distance roller is out from center of disc is directly proportional to WR.
- n. Velocity of roller is directly proportional to GS.
- o. 1 mile = 5,280 ft, 1 nautical mile = 6,080 ft, 1 knot = 1 nautical mile per hour.
- p.  $\text{Tan DA} = \frac{GS \times 1.47 \times ATF}{\text{alt}}$
- q. To change disc speed (decrease or increase of DS):  

$$\text{Amount of change} = \frac{\text{Error in mils}}{\text{Tan DA} \times 1000 \times DS}$$

R E S T R I C T E D

- r. Decrease in trail setting used with intervalometer for bomb spacing.
- $$\text{Decrease} = \frac{500 \times \text{No. of bombs} \times \text{bomb interval}}{\text{altitude}}$$
- s. 1 bubble length =  $2^{\circ}$ .
- t. 17.5 mils =  $1^{\circ}$ , i.e., 1 bubble length = 35 mil error.

## SECTION III

## CAUSES OF ERROR IN SYNCHRONIZED BOMBING

1. RANGE ERRORS SHORT CAUSED BY FOLLOWING:
  - a. Trail too small.
  - b. Altitude too low.
  - c. DS too slow.
  - d. Air speed too fast.
  - e. DA too large.
  - f. Fore and aft bubble displaced to the front.
  - g. Synchronization too fast.
  - h. Telescope cable too long.
  - i. Roller slippage.
  - j. Ship in glide when bomb is released.
2. REFLECTION ERRORS TO THE RIGHT CAUSED BY THE FOLLOWING:
  - a. Stabilizer twisted clock-wise.
  - b. Lateral bubble off to the left.
  - c. Dove tail misaligned counterclockwise.
  - d. Vertical hair drifting to the right.

CHAPTER TWO

FIELD CHECKS

SECTION I

PREFLIGHT INSPECTION

1. DUTIES. Bombardier officer assigned to plane is responsible for pre-flight inspection of bombsight.

2. PREVIOUS TO PRE-FLIGHT INSPECTION. a. Have auxiliary power to plane connected.

b. Check log book for 50 and 15 hour inspections.

3. PROCEED WITH PRE-FLIGHT INSPECTION. a. Turn stabilizer gyro switch ON.

b. Turn bombsight gyro switch ON.

c. Check coincidence of the optic indicator.

d. Test the action of the search knob — telescope drive clutch dis-engaged.

e. Test action of telescope drive clutch.

f. Check extended vision knob and leave in normal (full forward) position.

g. Uncage gyro and test action of the levelling knobs. Cage gyro.

h. Test the automatic release through the bomb racks.

i. Check telescope motor.

(1) Turn telescope motor switch ON.

(2) Check disc speed control at about five positions throughout range of disc speed knob.

(3) Take at least three tachometer readings in each position.

(4) Readings in each position should not vary more than  $\pm \frac{1}{2}$  RPM.

(5) Turn telescope motor switch OFF.

j. Check bubble and telescope cross-hair lights.

k. Check dove-tail alignment.

- (1) Place bombsight on exactly zero drift.
- (2) Place optic indicator on zero.
- (3) Sight through optics and rotate trail arm rapidly between

zero and 150 miles.

- (4) Allow no perceptible lateral motion of the fore and aft hair.

l. Check for zero-trail on cross-trail mechanism.

- (1) Remove bombsight stem locking pin.
- (2) Place the optic indicator on zero, bombsight on zero drift

and trail arm on exactly zero.

- (3) Sight through optics and rapidly rotate sight stem clockwise and counterclockwise. Allow no lateral motion of the fore and aft cross-hair.

- (4) Replace bombsight stem locking pin.

m. Check zero position of the roller.

- (1) Place optic indicator on zero. Place rate indicator on tan.05

ahead of zero.

- (2) Set trail arm on fifty mils. Set maximum disc speed.

- (3) Engage rate clutch.

- (4) Turn telescope motor switch ON.

- (5) Sight through optics; there should be no apparent fore and aft motion of the lateral cross-hair.

- (6) Place the trail arm on, first, 48 mils, then, 52 mils.

- (7) Movement of the lateral cross-hair should be just perceptible fore and aft respectively.

n. Check for roller slippage.

- (1) Set disc speed to 530 RPM.

- (2) Set trail arm at zero.

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(3) Place rate indicator at tan.3.

(4) With a bombardier's stop watch, check time required for optic indicator to travel from position of rate indicator to zero sighting.

(5) Time should be ten seconds plus or minus two-tenths second.

(6) Range indicator can then be placed at different positions on the rate scale and the timing repeated.

(7) Regardless of position of the rate indicator, it must take ten seconds for optic indicator to move from position of rate indicator to zero sighting angle.

(8) Turn telescope motor switch off.

o. Check servo motor action.

(1) Turn the servo motor switch on.

(2) Engage directional clutch (disengage secondary clutch).

(3) Apply a torque to the bombsight housing for about ten seconds in both directions.

(4) This torque should be resisted vigorously.

p. Check course knobs for operation.

(1) With directional clutch engaged, rotate the turn knob.

(2) Stabilized brush should move through the same angles as the bombsight.

(3) Try drift knob.

(4) Stabilized brush should move independently of the bombsight.

q. Check the action of the PDI. Turn the PDI switch on. With the turn knob rotate the PDI brush to the right. Pilot director indicator should be to the left.

4. INSTRUCTIONS FOLLOWING PRE-FLIGHT. a. Turn servo switch off.

b. Turn stabilizer switch off.

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- c. Turn bombsight switch off.
- d. Turn PDI switch off.
- e. Engage secondary clutch and disengage directional clutch.
- f. Disengage rate clutch.
- g. Check to see that bombsight gyro is caged.
- h. Set optic indicator at maximum sighting distance.
- i. Set disc speed knob at minimum.

## SECTION II

### ROUTINE 15 HOUR INSPECTION

1. STABILIZER. a. Clean and oil rotor bearings.

- (1) Remove bearing caps.
- (2) Use one drop of "H" oil only.
- (3) Do not over-lubricate.
- (4) When replacing bearing caps, make certain drain holes are on

the bottom.

b. Clean brushes, brush tubes and commutators.

- (1) Use clean white cloth to clean brushes.
- (2) Make certain to replace proper brush in tube correctly.
- (3) Use orange wood stick and cloth dampened with tetrachloride

to clean brush tubes.

(4) Clean commutator with cloth covered orange wood stick and gyro not turning over 500 rpm.

(5) Never use a tool for cleaning purposes.

(6) Before replacing brushes, check sides for shiny spots. If any spots are found, dress down lightly with crocus cloth.



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PRE-FLIGHT INSPECTION CHECK SHEET

M \_\_\_\_\_ NO. \_\_\_\_\_

DATE \_\_\_\_\_

\_\_\_\_\_  
(INITIAL)

1. Run Sight Gyro. \_\_\_\_\_
2. Check Coincidence of telescope pointers. \_\_\_\_\_
3. Test search knob action. \_\_\_\_\_
4. Test PDI action. \_\_\_\_\_
5. Test action of telescope drive clutch. \_\_\_\_\_
6. Test action of levelling knobs. \_\_\_\_\_
7. Check for pre-set trail. \_\_\_\_\_
8. Test automatic release. \_\_\_\_\_
9. Check telescope motor. \_\_\_\_\_
10. Check altitude knob and gear shift. \_\_\_\_\_
11. Check all lights. \_\_\_\_\_
12. Check extended vision. \_\_\_\_\_
13. Run stabilizer and servo motor. \_\_\_\_\_
14. Check action of servo motor. \_\_\_\_\_
15. Check clutch tensions manually. \_\_\_\_\_
16. Clean optics as necessary. \_\_\_\_\_

CHECK ALL SPACES IF THE UNITS ARE O.K.

DO NOT CHECK UNTIL ALL UNSATISFACTORY CONDITIONS ARE CORRECTED.

Figure No. 1

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c. Shaping flexible leads.

- (1) Do not touch by hand.
- (2) Use pencil or orange wood stick.
- (3) Shape should not permit leads to touch gyro case, stabilizer

case or each other.

NOTE: Often a burned out flexible lead will check for continuity but will not run gyro.

2. SERVO MOTOR. a. Clean and oil bearings (isolated on commutator end of motor and on end of spline shaft).

b. Use one drop of "L" oil.

c. Clean brushes, tubes, commutators.

- (1) Same as 1. b. above.
- (2) Make sure "hot brush" is thoroughly cleaned to prevent short-

circuit.

d. Check action of clapper magnets and servo clutches.

- (1) Make certain bayonet springs are not bent.
- (2) Make certain the clutch drags back against the cork faced

gear when magnet is de-energized.

e. Clutches.

- (1) Clutches and drums must be extremely clean.
- (2) Use cloth and carbon tetrachloride.
- (3) Use no abrasive materials.

3. PDI. a. Do not neglect to turn on switch.

b. When switch is on and PDI instrument checks "OK", check PDI brush.

c. Remove circular window above brush.

d. Press brush down on resistor coil.

e. Check for readings.

f. If there are no readings, bend brush to insure contact with coil.

g. If there are still no readings, check coil for broken wire or short circuit.

4. CAUTIONS. a. Use clutch puller, when removing secondary clutch.

(1) Threaded holes are provided for it.

(2) Do not pry it off.

b. Use fiber or wood plug to take off drift gear. Realign dove-tail after it is replaced.

c. Carbon brushes, when replaced, are clamped, not soldered, into clips.

d. If stabilizer does not run but source of power is working and there are no burned out wires, take following action:

(1) Snap commutator brush gently.

(2) If this does not help, check contact of slip ring brushes on slip rings.

5. BOMBSIGHT. a. Remove cover of oil gyro bearings.

b. Remove bearing cap to lubricate upper bearing. Use care.

c. Clean brushes, tubes and commutators. Use same procedure as with stabilizer (Paragraph 1., Section II).

d. Check levelling knobs.

(1) Remove and clean sticking levelling knobs.

(2) Examine lateral knob particularly.

(3) Clean leather washer if it sticks to carbon (use tetrachloride).

6. RATE END. a. Oil bearings.

(1) Oil telescope motor bearing sparingly.

(2) Clean telescope motor commutator very carefully.

(3) Allow new telescope motor brushes to run in rather than attempting to scrape them in.

(4) Minimum of 85% contact is needed for maximum disc speed.

(5) After changing brushes there should be 590 rpm's. (If not obtainable, do not attempt to tighten disc speed knob springs).

(6) In replacing bus bar, do not let flexible leads get between bus bar and mount.

(7) Keep shape leads away from case.

b. Telescope motor points.

(1) Clean with fine, platinum point file.

(2) Do not use carbon tetrachloride or crocus cloth.

c. Roller and disc.

(1) Keep very clean with carbon tetrachloride and clean cloth.

(2) Roller should turn freely in its carriage and upper bearing of roller.

(3) Lower bearing on spline shaft should be carefully lubricated.

(4) Check carefully to see that disc shaft does not bind in its block.

(5) Before replacing rate end cover:

(a) Zero trail arm.

(b) Use nut gear to run roller down as far as possible.

7. CALIBRATION. a. Remove pre-set trail.

(1) Check rate-end cover for pre-set trail, each time it is taken off and replaced.

(2) If found, remove rate end inspection plate.

(3) Set in maximum disc speed.

(4) Place rate index exactly at zero.

(5) Clamp trail arm on zero.

(6) Loosen trail arm set screw.

(7) Turn trail setting gear with thumb and forefinger in direction roller is turning until roller stops (inside rate end directly under trail plate).

R E S T R I C T E D

(8) Turn telescope motor off.

(9) Tighten set screw and move roller off center of disc.

b. Check for roller slippage.

(1) Determine ATF by dividing disc speed into 5300 (M 4, 5, 6, 7, and 9).

(2) Check for settings of the rate index .20 apart throughout the range of rate index.

(3) Read time when indices match and when telescope index reaches zero (allow .2 seconds for error).

(4) If time is erratic, it indicates roller slippage? In this case:

(a) Remove rate end cover.

(b) Reclean disc and roller.

c. Check telescope vertical.

(1) To establish telescope in vertical, be sure bubbles are level.

(2) Use precision mirror, bowl of mercury or any liquid that will seek true level and has power of reflection.

(3) With bubbles level and sight on zero sighting, look through telescope at mirror on base of stand on floor.

(a) Two images of the bottom of telescope will be seen in mirror.

(b) Cross hairs should split lower image (nearest observer).

(c) If necessary, rate hair may be adjusted by turning eccentric screw on No. 1 sheave.

(4) Position course hair by backing off cross trail locking screw on cross trail bell crank.

(5) Tap telescope gently to desired setting.

(6) Tighten screw carefully to avoid disturbing telescope setting.

R E S T R I C T E D

(7) Check that 20° extended vision is not in sight when establishing telescope in vertical.

d. Replacing telescope drive cable.

(1) Use care to avoid kinking cable, using tweezers as little as possible.

(2) Telescope cables should be fully wound on No. 5 sheave (on telescope cradle) when sight is at 70° angle.

(3) With telescope at about 30° sighting angle, place wad of paper, match or cloth between gear on #5 sheave shaft and gear of mirror quadrant.

(4) Thread cable through #4 sheave (thru telescope cradle gudgeon around sheave #5 and attach).

(5) Remove block and allow cable to wind itself around #5.

(6) Thread through remaining sheaves and attach to #1.

(7) Erect telescope to vertical.

(8) After replacing cable, check telescope for vertical as in Paragraph c. above.

8. PRECESSION OF SIGHT GYRO. a. Check for security of gyro gudgeon bearing holding screws. (In center of gudgeon bearing caps).

b. In making routine precision check, be sure gyro has run at least 50 minutes.

c. Start on east heading, bringing gyro in to about 16 to 17 mils east and not more than 5 mils north.

d. Go to north heading, making fine adjustments necessary. (Normally south and west heading will fall in.)

9. HINTS ON PRECESSION RUNS. a. On east heading, dented balls and races or dirty cardan gudgeon bearing will show up in following manner:

(1) Gyro will precess east in normal manner to 8 or 10 mils.

(2) Easterly precession will then slow down or stop, and gyro will rapidly hook to north.

b. Correct as follows:

(1) Clean cardan gudgeon bearings.

(2) Turn race of free end cardan gudgeon bearings  $180^{\circ}$  to get away from ball dents.

c. A pendulous gyro will tend a spiral. Correct as follows:

(1) Go east, then north, and finally west.

(2) Clean gyro thoroughly with carbon tetrachloride.

(3) Relubricate and continue precession check.

d. A top heavy gyro is recognized by erratic precession reading.

Correct as follows:

(1) Let gyro get cold.

(2) Force it gently down to its proper seat, with two fiber punches through the two holes on top of gyro case.

(3) Resume precession runs after proper period of warm up.

10. ADJUSTMENT OF DRIFT KNOB. a. If inside knob is bending or too loose, giving noticeable back lash, take following action:

(1) Loosen set screw on drift knob shaft housing.

(2) Then move drift worm to mesh properly with drift gear.

(3) Tighten set screw.

b. If, when double gripping, both knobs jam and cannot be turned, take following action:

(1) Check lock nut on drift knob shaft -- loosen.

(2) Separate drift from turn knob about .005.

(3) Lock nut tightly.

15 HOUR INSPECTION FORM

Sight # \_\_\_\_\_ Mechanic \_\_\_\_\_ Date \_\_\_\_\_

SIGHT

STABILIZER

1. Outer case inspected \_\_\_\_\_

1. Outer case inspected \_\_\_\_\_

2. Rate End:

2. Clutches:

Housing cleaned \_\_\_\_\_

Directional clutch cleaned \_\_\_\_\_

Wiring checked \_\_\_\_\_

Secondary clutch cleaned \_\_\_\_\_

Disc cleaned \_\_\_\_\_

Drum cleaned \_\_\_\_\_

Roller cleaned \_\_\_\_\_

3. Stabilizer Gyro:

Brushes checked \_\_\_\_\_

PDI rheostat checked \_\_\_\_\_

Commutator cleaned \_\_\_\_\_

Isolated sector checked \_\_\_\_\_

RateMotor Breaker points checked \_\_\_\_\_

Wiring checked \_\_\_\_\_

3. Sight:

Bearings oiled \_\_\_\_\_

Housing cleaned \_\_\_\_\_

Commutator wiped clean \_\_\_\_\_

Wiring checked \_\_\_\_\_

4. Calibration:

Brushes checked \_\_\_\_\_

Tension adjusted:

Gyro bearings oiled \_\_\_\_\_

Directional clutch (18-22) \_\_\_\_\_

Commutator wiped clean \_\_\_\_\_

Drift gear (6-8)

Running time: Sight \_\_\_\_\_

Remarks \_\_\_\_\_

Running time: Stabilizer \_\_\_\_\_

Man hours: Sight \_\_\_\_\_

OK'd by \_\_\_\_\_

Man hours: Stabilizer \_\_\_\_\_

(NCO in charge)

Figure No. 2

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# SECTION III

## TROUBLE SHOOTING

1. CHECK SHEET FOR DETERMINING MALFUNCTION. If errors in bombing or malfunctions are encountered and it is not definitely known that a malfunction exists, then the following checks will be made before a malfunction report is submitted:

- a. Make complete pre-flight inspection of all bombing equipment.
- b. Check altitude computations for correctness and correct altitude and air speed being used.
- c. Check bombing tables and target information for correct data used.
- d. Check all switches and controls for proper position.
- e. Check data set in sight for correctness (proper use of tach).
- f. Check that secondary clutch is not engaged.
- g. Check that extended vision knob is in proper position.
- h. Check leveling knobs for sticking.
- i. Turn switches on and off several times when some unit fails to operate.
- j. Check hi-low DS shift for proper position.
- k. Check fuses that bombardier can replace.
- l. Check generators in ship for switches "on" and voltage output.

2. TROUBLE SHOOTING CHART. a. Deflection errors.

<u>Trouble</u>	<u>Check</u>	<u>Correction</u>
(1) Pre-set trail in cross-trail mechanism.	Setting: Set trail arm and telescope index at zero. Remove sight stem pin. Check: Look into optics and rotate bottom of shaft. No transverse motion of the fore and aft cross-hair should result. If motion does exist, it means that there is pre-set trail in the cross trail mechanism.	Check to see that the scribed mark on the cross trail rack gear is opposite the scribe mark on the trail arm pinion when trail arm is at zero. If not, remove trail arm pinion and align scribe markers with trail arm set at zero. If the above condition does not exist it means that the bell crank linkage from the cross trail rack gear to the push rod is out of alignment. Change shims of bell crank to correct
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<u>Trouble</u>	<u>Check</u>	<u>Correction</u>
(2) Dove-tail misaligned.	Settings. Set sight on zero drift. Check to see that sight stem pin is in. Check that telescope index is on zero. While moving trail arm back and forth through entire range, look into the telescope and observe fore and aft cross-hairs. The fore and aft cross-hair should not move transversely; if it does, the dove-tail is out of alignment with the longitudinal axis of the stabilizer and sight.	Loosen the four screws of the bombsight stem locking bracket and turn bracket in the elongated screw holes until motion of the fore and aft cross hair ceases when trail arm is moved. CAUTION: This adjustment is very fine and when tightening screws do it slowly to make sure that the bracket does not move.
(3) Telescope out of vertical.	Refer to 15-hour Inspection.	Refer to 15-hour Inspection.
(4) Erratic PDI	Check Bombardier's PDI with Pilot's PDI.	Clean PDI rheostat and brush on stabilizer. Make certain brush is making proper contact on rheostat. Check drift gear for proper tension.
(5) Lateral leveling knob sticking.	Check to see if knob springs out after releasing.	Check for binding of shafts due to dirt, corrosion, etc. Disassemble, clean and oil, if necessary.
(6) Directional clutch slipping.	Clutch in directional. Clutch and apply torque to sight. If sight turns easily, the clutch has improper spring tension.	Adjust spring tension to 18-22 lbs. by use of spring scale.
(7) Drift gear slipping.	Turn drift knob and watch PDI. It should move evenly and smoothly; if movement is erratic, drift gear is too loose.	Adjust spring tension to 6-8 lbs. by use of spring scale.
(8) Servo motor.	Clutch in direct clutch and attempt to rotate sight. If direct gyro dips and sight tends to rotate of its own accord in direction of force; then servo motor is not working properly.	Check commutator and brushes. Check wiring. Check clutches and solenoids. Check isolated sector and brush.
(9) Course knobs.	Turn each knob. They should move freely.	Check for burrs and high spot in gears. Check for binding of shafts and gears.

b. Range Errors.

<u>Trouble</u>	<u>Check</u>	<u>Correction</u>
(1) Pre-set trail or incorrect zero position of roller.	See Section II, Paragraph 3.1.	Refer to 15 hour inspection.
(2) Improper mirror cable length.	Set telescope index at zero. Check to see if coincidence points match. If they do not, then cable is too long or too short.	Adjust coincidence points by eccentric screw on first sheave.
(3) Roller slippage.	See Section II Paragraph 7. <u>b.</u> (1) (2) (3) (4).	If roller slipping, check for excessive oil on disc and roller; proper spring tension and friction through gear train.
(4) Erratic disc speed.	Take several readings with tachometer. If readings are erratic it indicates erratic disc speed.	<u>Check</u> , clean adjust: 1. Commutator and brushes. 2. Breaker points. 3. Loose wiring. 4. Governor. 5. Breaker arm. 6. Optic clutch pin.
(5) Vertical gyro failure (can cause both deflection and range errors.)	Usually recognized by reaction of gyro to leveling knobs. If gyro is very sensitive or reacts fast to leveling knob correction, the gyro is not turning up to its maximum. If gyro tumbles when uncaged, the gyro is completely out.	Check for defective wiring, commutator, carbon, brushes and proper voltage.

SECTION IV

ANTI GLARE EQUIPMENT

1. SELECTION OF THE CORRECT FILTER. To aid the bombardier in the selection of the correct filter, a glare table is used to give the conditions under which best results are obtained. (See Figure 3.)

2. INSTALLING THE FILTER. a. Filters are mounted in retainers (similar to bombsight eyepieces).

b. Rudder eyepiece vest is furnished with filters.

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GLARE TABLE FOR USE WITH M-SERIES ANTI-GLARE EQUIPMENT

<u>Visual Conditions Affecting Target</u>	<u>Counteracting Filter Type</u>
Glare from snow	Plain polaroids at low and minimum altitudes (1,000 to 12,000 feet).
Glare from water.	Plain polaroids at low and medium altitudes (1,000 to 12,000 feet). Light yellow filter at high altitudes (20,000 feet). Dark yellow filter at high altitudes (20,000 feet). Red filter at high altitudes (20,000 feet).
Glare from sandy soil.	Light yellow filter; dark yellow filter.
Glare from white sand.	Light yellow filter; dark yellow filter.
Heading into sun.	Light yellow filter; dark yellow filter.
Cutting through haze, fog, overcast, and shadows.	Dark yellow filter; red filter.
Searchlight glare.	Plain polaroids at any altitude.

NOTE 1. In broken cloud formations, the plain polaroids cut out all weak cloud formations and leave solid cloud banks more sharply defined.

NOTE 2. Nature of terrain, altitude of mission, the size of the objective, lighting effect, and the weather will affect efficiency of filters.

NOTE 3. The applications of the filters overlap; thus, experience and judgment of bombardiers will be the deciding factor for choosing proper filter.

Figure No. 3

c. Remove present eyepiece and set proper filter into the rubber eyepiece provided.

d. Insert eyepiece into the eyepiece sleeve of the bombsight.

3. USE OF POLAROID FILTERS. a. These filters must be adjusted to reduce glare to a minimum.

b. Adjustment is obtained when plane of polarization is aligned properly with the target.

c. Alignment is obtained by twisting entire filter assembly in its seat until glare is minimized.

4. USE OF ADJUSTABLE FILTER. a. Differs from other filters.

b. Has two-fold purpose.

(1) Reduces or eliminate glare, and

(2) At same time varies total amount of light transmitted to the eye.

c. To obtain variation in the transmitted light, rotate inner ring of the assembly over its arc of rotation until desired amount of light is allowed to pass through.

d. Light transmission varies from total extinction to about 40% transmission.

e. Adjustable unit effective when the filters are not.

5. CARE OF EYEPIECE FILTERS. a. When not used should be kept in container case.

b. Should never become damp or dirty.

c. Should be cleaned by:

(1) Breathing on active surfaces.

(2) Polishing with soft cloth or lens paper (or cotton).

d. Should never be washed with water.

e. Should never be left in warm place.

f. If necessary, grain alcohol on cloth may be used sparingly; glass surface of filter must be free of grit in this case.

## SECTION V

## COLD WEATHER OPERATIONS AND USE OF HEATING COVERS

1. EFFECT OF TEMPERATURE ON WORKING EFFICIENCY.
  - a. Bombsight and stabilizer need not be pre-heated at temperature of  $-5^{\circ}\text{F}$  ( $-20^{\circ}\text{C}$ ) or more.
  - b. Above temperature must be maintained regardless of ambient temperature.
  - c. Temperature of units should be maintained above ambient for maximum efficiency.
2. WHEN BELOW MINIMUM REQUIREMENTS. If unit temperature is likely to fall below minimum temperature limits, action should conform to that explained in Paragraph 1.
3. HEATING COVERS NOT AVAILABLE. When heating covers are not available and ambient temperature is below specified limit for bombsight, take following steps:
  - a. When ground temperature is below minimum required, place bombsight and stabilizer in a dry room with satisfactory temperature.
  - b. If not to be used soon, pack each bombsight in an individual storage case with  $\frac{1}{2}$  pound dessicant (silica gel).
  - c. Storage case must be as airtight as possible.
  - d. Never place a cold sight in a warm humid room.
  - e. Equipment should have warm up period of at least two hours before being taken out of storage (when necessary).
  - f. During warm up units should be covered with blanket.
  - g. After installation (just before take off) units should be recovered and operated after turnover of engine.
  - h. During flight, temperature of the two units should exceed that of bombardier's compartment. Hence, take following action:

(1) Keep bombsight covered and in continual operation.

(2) A-1 heated cover should be removed only on tactical mission or when bombsight temperature is well above the ambient.

1. Should units fall below  $-5^{\circ}\text{F}$ , take following action:

(1) Turn on switches alternately for periods of 5 to 10 seconds.

(2) No two switches should be turned on at the same time until all units warm up.

(3) After all motors are running satisfactorily, operate rate and motor switch in the same manner.

4. USE OF HEATING COVERS. a. Bombsight cover, Type A-1, is an electrically heated cover with connecting cord.

(1) Cover operates on 29 volts DC or AC service.

(2) Will maintain minimum temperature within bombsight of  $15^{\circ}\text{F}$  (or  $-9\frac{1}{2}^{\circ}\text{C}$ ) when ambient temperature is minimum  $60^{\circ}\text{F}$  ( $-51^{\circ}\text{C}$ ).

b. Use cover only during freezing or excessive humidity.

c. Heat cover while bombsight is warming up.

d. Never permit temperature of bombsight to fall below  $+5^{\circ}\text{F}$ .

e. Sight must run minimum of  $\frac{1}{2}$  hour before takeoff, with cover heat "on" at the time.

f. Generally, keep sight heated so that its temperature always exceeds that of surrounding air.

5. INSTALLATION AND OPERATION. a. How to install.

(1) Loosen locking device on draw string of cover.

(2) Open up mouth of cover to maximum opening.

(3) Place hand-held tachometer in tachometer case and place case in its pocket.

(4) Hold cover open with left hand below junction box; right hand opposite side.

(5) Slide cover over overhanging part of sight and pull down snugly over remainder.

(6) Tighten drawstrings and slide locking clamp into place.

b. Use on ground.

(1) Cover may be used in low or humid temperature.

(2) Secure a standard transformer (300 watts, 110 volt primary and 28 volt secondary).

(3) Plug cover circuit into transformer secondary leads.

(4) Plug transformer primary circuit lead into the standard receptacle circuit auxiliary oil.

c. Use in flight.

(1) When temperature requires, plug connecting cord into 24V PLA rheostat of the plane.

(2) When temperature requires, keep sight operating with the cover on and heating.

(3) When target is approached, loosen draw string and open mouth of cover to its maximum opening.

(4) When necessary, to remove cover, grip the two handles and pull upwards. Disconnect cover from power supply when removing.

(5) After leaving target, replace cover on sight.



## CHAPTER THREE

## THE C-1 AUTOMATIC PILOT

## SECTION I

## GROUND CHECK

1. BEFORE PREFLIGHT.
  - a. Connect auxiliary power to the airplane.
  - b. Disengage control locks.
  - c. Turn all knobs on the pilot's control box to "pointer-up" position.
  - d. Place turn control in detent position.
2. PROCEEDING WITH PREFLIGHT.
  - a. Throw master switch on pilot's control box on.
  - b. With the master switch on, check to see that the following units are operating.
    - (1) Directional gyro in bombardier's compartment.
    - (2) Flight gyro.
    - (3) Rotary converter.
    - (4) Aileron, rudder, and elevator servo motors.
  - c. Thirty seconds after master switch has been thrown on, turn on direction gyro servo and PDI switches on pilot's control box. (On some airplanes servo and PDI switches are one switch.)
  - d. Turn on tell-tale switch.
  - e. Move aileron control wheel throughout its range. The right and left aileron lights should not flicker but should burn steadily, and only one light should be on at a time. As the dead spot area is passed, the opposite light should go on.
  - f. Move the elevator control column for same check.
  - g. Move rudder pedal for same check.
  - h. After master switch has been on for about five minutes, place all controls in approximate neutral and throw aileron, rudder, and elevator switches

on.

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i. Over-power all controls, one at a time. Considerable force should be encountered.

j. Next try the centering knobs.

(1) Rotating the aileron centering knob clockwise should cause the aileron wheel to rotate clockwise.

(2) Rotating the rudder centering knob clockwise should cause the right rudder pedal to move in.

(3) Rotating the elevator centering knob clockwise should cause the control column to move to the rear.

k. Next try the turn control.

(1) Place the turn control on zero (just out of detent) and check to see that the secondary arm locking solenoid is energized and locks the secondary clutch.

(2) Rotate the turn control clockwise. Aileron control wheel should rotate clockwise and right rudder pedal should move forward.

(3) Return turn control to detent.

l. Next, try the action of the secondary clutch.

(1) Unclutch secondary clutch and move to the left.

(2) Aileron and rudder control surfaces should move so as to give a right turn.

m. Check sensitivity on all axes as follows:

(1) Turn sensitivity clockwise all the way on each axis.

(2) Move the centering knob on each axis two serrations, with respect to the pointer. Controls should move slightly.

n. Check ratio on all axes. Rotating the ratio control on each axis clockwise and counterclockwise should cause the controls to move slightly.

o. Continue as follows:

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- (1) Throw C-1 automatic pilot master switch off.
- (2) Shut off auxiliary power.
- (3) Re-engage the control surface.
- (4) Check to see that the turn control is in detent.
- (5) Turn off tell-tale light switch.
- (6) Check to see that all knobs on pilot's control box are turned to pointers-up position.
- (7) Check to see that secondary clutch is engaged and primary clutch is disengaged.

## SECTION II

## AIR ADJUSTMENT

1. CHECKS. a. Check pilot control box to see that all pointers are at the 12 o'clock position, and that the turn control is at the center position.  
b. After ship has taken off and has gained desired altitude, turn on master bar switch.  
c. Two minutes after previous operation, turn on PDI and servo switch.  
d. Wait fully ten minutes for the equipment to warm up.  
e. Trim to fly straight and level hands off.
2. SECONDARY CLUTCH. Disengage secondary clutch by rotating knurled knob counterclockwise, full against the stop. Now the PDI may be centered as indicated by the pointer, and arm lock held down manually until further notice from the pilot.
3. ENGAGING PILOT. a. Pilot will rotate aileron centering knob until aileron lights go out, then immediately throw aileron lock switch on. The same procedure will apply for all three centering knobs and locking switches.  
b. The secondary clutch may now be engaged by turning knurled knob clockwise, full against stop, releasing arm lock.

4. SENSITIVITY. a. Turn aileron sensitivity knob clockwise to the point where the controls vibrate.

b. Then turn counterclockwise until vibration ceases.

c. The previous step applies to all three sensitivity knobs.

5. RATIO. a. Turn aileron ratio clockwise until wings oscillate with respect to the horizon; then counterclockwise until oscillation ceases.

b. Turn rudder ratio knob clockwise until ship fishtails; then rotate counterclockwise until movement ceases.

c. Turn elevator ratio knob clockwise until ship pitches up and down; then counterclockwise until no movement.

6. TURN COMPENSATION. a. Secondary clutch is now disengaged, moved to the right for a left turn, and held full against the stop.

b. At same time, pilot adjusts aileron compensation knob until 18° bank is indicated by flight indicator.

c. Rudder compensation knob is adjusted until the ball bank indicator has ball on the high center side of the turn.

d. If altitude is not constant, adjust up-elevator compensation knob to maintain altitude.

e. Center PDI and engage secondary clutch.

7. OPERATING TURN CONTROL. While coming out of the turn in operation of the turn control:

a. The knob must be brought back to zero position.

b. It must be held there until ship has assumed a straight and level flight before placing pointer in center position.

8. TRIM. With auto-pilot engaged DO NOT TRIM SHIP WITH TRIM TABS. If trim is necessary, use centering knobs or disengage system; then retrim with ship trim tabs and re-engage pilot.

## SECTION III

## 25 HOUR INSPECTION

1. VISUAL INSPECTION. Check all units for frayed wires, bad connections, loose screws, burred and oily commutators.
2. CLUTCH TENSION. Turn on master switch and wait approximately 5 minutes before turning on PDI and servo switch. In ten minutes the flight gyro should erect to within  $2^{\circ}$  of the vertical.
  - a. After this time the directional gyro should be checked for precession. Clutch in the secondary clutch on zero. There should be no movement of the PDI thereafter. Allow to run for 15 minutes.
  - b. Adjust clutch tension on all three clutches: directional, 18 to 22 lbs., secondary, 10 to 14 lbs., drift, 6 to 8 pounds.
  - c. Check for proper functioning of dashpot.
  - d. Check locking solenoid release.
3. CLEANING.
  - a. Remove covers and inspection plates, from flight gyro, servo motor, and directional panel.
  - b. Clean with line-free rag and alcohol or white gasoline.
  - c. Wipe wipers over each potentiometer after cleaning.
4. BRAKE LOCKING LEVER. Brake locking lever should be checked for release. When pressure is off, lever should spring back to stop screw head.
5. RELAYS. Relays in amplifier should be free from pits. If pitted, dress with a swiss file and crocus cloth.
6. BRUSHES. If used constantly above 20,000 feet, brushes should be inspected and replaced every ten hours.
7. POTENTIOMETER CHECK.
  - a. With lights on, work controls manually.
  - b. Flickering of lights will indicate dirty or open potentiometers.

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8. SENSITIVITY. Check sensitivity by noting increased flickering of tail-tale lights.

9. RATIO CONTROL. a. Check ratio control by moving knob and noting action of control in direction of rotation. On the rudder the FDI should be 1° off center.

b. With the brake switches off, move the controls manually from one extreme to another to check for dirty or open balance pots.

(1) The lights will flicker during movement if dirty or open.

(2) If required, clean with alcohol and wipe dry with a lint-free cloth.

10. TURN CONTROL. While examining turn control, check for proper coordination of aileron and rudder.

## CHAPTER FOUR

## ARMAMENT MAINTENANCE

## SECTION I

## THE CALIBER 0.50 AIRCRAFT MACHINE GUN, M-2

1. GENERAL. The Browning Aircraft Machine Gun, caliber 0.50, M-2, is a highly efficient automatic weapon built to precision standards. Given proper maintenance and correctly adjusted, this gun outperforms weapons of comparable caliber and weight in use by any other nation. At least 95% of all malfunctions may be traced to improper maintenance or lack of training on the part of the operator.

2. ADJUSTMENTS. a. Contrary to previously taught methods, headspace MUST be adjusted after the weapon is completely assembled. In order to make a true headspace adjustment, the length of the threaded portion of the barrel must be such as to allow it to project slightly through the barrel extension when screwed in all the way.

b. Approved method. (1) Retract the action of the gun about one inch and, with the point of a cartridge, screw the barrel in until the action will not close.

(2) Unscrew barrel one notch at a time until action will just go home. Unscrew barrel two more notches.

(3) In screwing barrel in or out, always use the point of a cartridge or other soft tool; never use a screwdriver.

3. WEIGHT TESTING. a. It is necessary to insure that the counter-recoil action has enough force to pull long cartridge belts into the feedway.

b. Approved method: (1) Attach a 17-pound weight by cord to a belt containing 12 dummy rounds.

(2) Engage the belt in the feedway and pass the cord over a pulley (a bomb hoist pulley held in a bench vise is satisfactory) in such a manner that the cartridge belt extends horizontally from the feedway.

(3) Hand operate the gun a sufficient number of times to assure that the mechanism fully closes under action of the driving spring.  
(NOTE: 56 cartridges in links weigh 17 pounds; roll into compact bundle and tape).

4. TIMING. a. Timing the Basic Gun. The purpose of timing is to insure that the gun is not fired too early or too late.

(1) During automatic firing, the gun must fire not later than 0.020 inch out of battery.

(2) Only when the first cartridge of a burst is being fired should the firing pin be released with the recoiling portion in the battery position.

b. Approved method of checking (using gages No. A351212 and No. A351214):

(1) Adjust headspace as above.

(2) Cock the gun by fully retracting the recoiling parts and allowing them to go forward into battery.

(3) Remove back plate and driving spring assembly.

(4) Retract the recoiling parts slightly and insert the "FIRE" portion No. A351214 of the timing gage between the barrel extension and the trunnion block.

(5) Allow the barrel extension to close slowly on the gage.

(6) Release the firing mechanism by means of the trigger bar.  
(The firing pin should release).

(7) Remove the "FIRE" gage, cock the gun and insert the "NO



FIRE" gage No. A351213 as in step No. 2 and No. 4 above, between the barrel extension and the trunnion block.

(8) Allow the barrel extension to close slowly on the gage.

(9) Release the firing mechanism (The firing pin should not be released).

(10) If the firing pin does not respond to the "FIRE" and "NO FIRE" gages, as described above, replacement of the trigger bar is necessary.

(11) In order to select a new trigger bar, remove the faulty one from the gun and place it on a trigger bar-pin for comparison with other trigger bars.

(12) Line up the rear ends of the bars and select one on which the cam surface at the front will depress the sear either earlier or later as desired.

c. Timing with the Solenoid. The tendency at present is to fire all guns, both turret mounted and hand held, by means of an electrical solenoid. The standard solenoid is the type G-11, mounted on the buffer tube assembly. This solenoid is extremely sensitive to voltage and will only work properly when the engines are running (generator putting out). Therefore, final adjustments should be made in the air.

d. Approved method. (1) Adjust only after proper headspacing.

(2) Assemble the back plate to the gun, taking care that the flipper is lying flat against the back plate.

(3) Turn the adjustment cap at the rear of the solenoid to the right (clockwise) until it comes to a stop.

(4) Turn the adjustment cap to the left (counter clockwise) approximately  $1\frac{1}{2}$  turns. Continue from this point one notch at a time until the setting is found where the firing pin is just released the first time the

solenoid is operated. Charge the gun two or three times to make sure that this setting is correct.

(5) Turn the adjustment cap an additional three notches to the left (counter-clockwise). Check this adjustment by charging the gun and inserting the .020 inch gage between the trunnion block and barrel extension. The firing pin must be released the first time the solenoid is operated. Again charge the gun and insert the .118-inch gage between the trunnion block and barrel extension. With this gage in place, the firing pin must not be released. Again operate solenoid ONCE ONLY.

5. HANDLING AMMUNITION. a. A great deal of gun trouble is caused by improper handling of ammunition. Although small arms ammunition is relatively safe to handle, great care must be exercised to prevent damage to the loaded belts. Belts should never be dropped or stretched, and must be kept free of dirt, grit, grease, oil, water, etc.

b. Short rounds are very easily caused by rough handling of belted ammunition, and a short round will cause a stoppage in nearly every case. The complete belt must be removed from the gun and the defective cartridge removed from the belt by hand. In the case of power turret guns, this would cause the loss of one gun until after the action. Ammunition should always be inspected carefully before loading into the airplane. Damp ammunition will freeze at high altitudes.

c. Armor piercing ammunition must be handled even more carefully than other types and the mouth of the case is crimped into the bullet cannelure and a minimum pull of 100 lbs. is required to extract the bullet from the case. However, due to the solid nature of the core, all of this crimping must be absorbed by the thin gilding metal jacket, and rough treatment will cause loose rounds and short rounds in every case. Also, because of this

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same lack of "give" in the projectile, it is not considered safe to use armor piercing ammunition in a new barrel. The barrel should first be treated by firing 100 rounds of ball ammunition before any armor piercing ammunition is used. In unloading guns using armor piercing ammunition, care must be taken when extracting the round from the chamber to see that the projectile is not left in the barrel.

6. TIGHT CHAMBERS M2, ALL TYPES. a. Frequently, when extracting a live round by hand-charging, the bullet jams in the chamber, putting the gun out of action until the bullet is driven out of the chamber, and all trace of loose powder is removed. In most cases, this is caused by the following conditions:

- (1) New barrel with minimum size chamber.
- (2) Maximum round.
- (3) Loose bullet.

b. To avoid this malfunction, all caliber .50 machine gun barrels to be manufactured in the future will have the bullet seat located forward one-quarter inch in accordance with chamber and rifling drawing No. 064348, revised March 2, 1942. To correct barrels now in service, caliber .50, chamber reamers No. C121020 have been furnished to all ordnance maintenance personnel. Instructions for the use of the reamers were furnished with them.

c. Pending the correction of barrels in service and in storage the the following precautionary measures must be taken, particularly where combat is anticipated:

- (1) Inspect each round of caliber .50 armor piercing ammunition by pulling on the bullet to determine if it is loose. Reject all ammunition with loose bullets.

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(2) When practicable, use barrels that have fired at least 100 rounds in a continuous burst.

(3) If a new barrel is used, charge the gun manually, using a round of armor-piercing ammunition, to determine whether the bullet is engraved by the lands. If the bullet is engraved, the barrels should be fired a continuous burst of 100 rounds, ball ammunition, or reamed as prescribed in sub-paragraph above.

(4) Hand-charging of guns with the cartridge in the chamber should be held to a minimum.

(5) Barrels to be manufactured in the future, and barrels now in ordnance storage to be modified in accordance with chamber and rifling drawing No. 064348, revised March 2, 1942, will be piece-marked:

"Aircraft barrels: D35348A-7 or D28272-9", (depending on type).

7. PREVENTION OF SLUGGISH OPERATION. a. When operating at extremely high altitudes, an excessive coating of oil will cause sluggish action and may even bring about a complete stoppage. Oil on the firing pin spring, congealing at high altitudes, would cause the spring to lose its power and the firing pin would strike the primer with insufficient force to prime the cartridge.

b. Guns must be cleaned scrupulously; all burrs and roughness removed by careful stoning, wiped carefully with an oily rag and then all traces of oil removed with a clean, dry rag.

c. Upon returning from a mission, the gun must be cleaned carefully and sufficiently oiled to prevent rusting, bearing always in mind the fact that all traces of oil must be removed before again sending the gun to high altitudes.

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d. Another factor resulting in sluggish operation of the machine gun at high altitude is the thickening of the oil (Spec. 2-27) with which the oil buffer is filled. This slows the oil buffer piston to such an extent that the rate of fire of the gun is reduced by 50%, even though the restricted openings are completely opened. Korosene and Prestone have been used as substitutes for the oil with varying results. The gun has even been used with an empty oil buffer. With light bodied solutions, or no solution at all in the recoil absorbing buffer, the rate of fire was greatly increased. This, in time, would cause considerable damage to the guns, due to excessive pounding and wear of parts, with increased prospects of stoppages through breakage.

e. When the rate of fire is increased by any of the above methods, the buffer discs in the buffer tube are hammered thin by the increased recoil force of the bolt. This causes the discs to spread and bind on the sides of the buffer tube; there is even some danger of the buffer tube bursting. It is, therefore, considered good practice to drill a 1/8" hole through the center of the fiber discs, thus permitting expansion inward instead of outward against the buffer tube.

f. The practice of firing short bursts to warm the guns, as the aircraft climbs to high altitudes, has been abandoned, as the changing temperatures cause moisture to collect in the guns which then freeze.

g. The muzzles of all guns should be kept covered with tape at all times, as dirt and moisture will enter the bore and the barrel will be rusted quickly.

8. MALFUNCTIONS. a. A malfunction is an improper or incomplete action of some part of the gun or its ammunition which results in a cessation of fire

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called a "stoppage". There are three positions of stoppages:

(1) First Position Stoppage. One which occurs when all recoiling parts are in their extreme forward or battery position.

(2) Second Position Stoppage. One which occurs when the recoiling parts are at any position from just out of battery to the position when the bolt is halfway back of battery.

(3) Third Position Stoppage. One which occurs when the bolt is in any position from halfway back to all the way back.

b. Immediate action after stoppage.

(1) Loosen cover.

(2) Straighten belt.

(3) Close cover.

(4) Charge gun (note if belt feeds, and the round is ejected).

(5) If cartridge is ejected and belt feeds:

(a) Fire.

(b) If gun still fails, check for ruptured cartridge.

(6) If belt does not feed:

(a) Raise cover (remove first round from belt).

(b) Reload, recharge, fire.

c. To stop runaway gun, raise cover plate.

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## SECTION II

## BOMB RACKS AND RELATED EQUIPMENT

1. GENERAL. a. Bomb racks may be either internal or external to the surface of the carrying airplane. In heavy bombardment, bombs normally are carried internally as the center of gravity of each bomb of the bomb load must be as close to the center of gravity of the airplane as possible. Thus, the release of a bomb and the consequent sudden decrease in load may not disturb the steady horizontal flight of the airplane. Although bombs carried externally may seriously interfere with the performance of the airplane, the trend at present is towards external racks as an auxiliary means of increasing the capacity of our heavy bombers.

b. An internal bomb rack is an arrangement of supports built as an integral part of the airplane to provide suspension points for carrying the various bombs comprising the bomb load.

c. Between the bomb rack and the Bombardier's controls is a series of linkage rods or cables, or a combination of both. It is understood that these will be eliminated in the near future, as an electrically operated system has been developed.

d. As a connecting link between the bomb and bomb rack, a bomb shackle is provided. This is a necessary link in the carrying, releasing, and, in some cases, in the arming mechanism in use with internal bomb racks.

2. MAINTENANCE. a. Bomb shackles are designed to operate without lubrication and must be kept free from oil and dirt. They may be cleaned with kerosene after which they should be thoroughly blown dry with air. Shackles are well made and there have been very few reports of malfunctions. Following is a chart of bomb shackle types and capacities.

(1) When carrying 1400-lb. bomb on B-7 shackle, the safety factor is reduced. Severe maneuvering will be avoided and airplane will not be landed with this load.

(2) Before loading a 2000-lb. or 4000-lb. bomb refer to Tactical Orders for specific plane.

b.

BOMB SHACKLE CAPACITIES

TYPE OF BOMB SHACKLE			
B-7	B-9	D-4, D-6 D-7	D-8
100#	100#		
300#	300#		
500#	500#		
1000#	1000#		
1400#			
			1600#
		2000#	2000#
		4000#	4000#

Figure 4.

3. RELEASE MECHANISM. a. If precision bombing is to be obtained, positive and instantaneous release is necessary and the equipment must permit either "armed" or "safe" dropping of the bombs. These requirements are accomplished by the bomb release unit (A-2 release or A-4 release).

b. Description: The type A-2 bomb rack release operates on 24 to 28½ volts direct current and draws 6 amps at 24 volts. Electrically, it releases the bomb "armed", provided the arming wire is inserted in the arming wire retainer, and, manually, it salvoes the bomb "safe".



c. Proflight inspections: Check each Simmonds fastener or ring for excessive wear or looseness.

d. Pre-loading checks: (1) Open bomb bay doors and check for proper operation

(2) Place bomb controls in selective position.

(3) Cock all bomb stations.

(4) Place bomb control handle in locked position.

(5) Test each A-2 Release by trying to trip with a screwdriver; if release will trip, the linkage must be adjusted.

(6) Be sure there is no bomb-bay gas tank on racks, cock all A-2 releases; move bomb control handle slowly to salvo position. This will allow all play in bomb rack control linkage to be taken up and all releases should trip. If any fail to trip, control rods must be adjusted until all releases will trip.

(7) With bomb controls in salvo position and all A-2 releases tripped, try to cock each release. If any release hangs slightly; it is an indication that the release is not completely in salvo and control linkage must be adjusted.

(8) Place bomb controls in selective position and trip all stations electrically through bombsight.

(9) Any adjustment made on one section of the racks will affect all releases on that section.

(10) In adjusting the connecting linkage between the bombardier's control handle and the salvo bar, there may be a difference in the positioning of internal parts and linkage when the airplane is in the air with the weight supported by the wings. Apparently, there is a redistrib-

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ution of stresses after leaving the ground and, unless the rack is adjusted to take advantage of the full four degrees of "selective", it may be possible to have the control handle in the selective position and some of the releases in lock. This may explain some of the very numerous cases where the racks check out all right on the preflight, but fail to release all of the bombs in the air.

(11) The type A-4 release is similar to the type A-2 except that the manual controls have been replaced with electrical, thus eliminating the long linkage between the bombay and the bombardier's compartment.

4. SELECTIVE ARMING. a. In order to provide selective arming of the nose or tail fuse the bomb arming control boxes, types A-1 and A-2 were designed. Although they differ in appearance, in operation they are similar and either one may be used.

b. The bomb arming control will accommodate only one arming wire so one control is mounted at each end of the bomb station, either the nose or tail fuse, or both, may then be armed by manipulating switches in the bombardier's compartment.

c. Prior to each bombing flight, test the bomb arming control for the following load characteristics with a standard arming wire.

- (1) With magnet energized, it must hold a 100-lb. load.
- (2) With the magnet de-energized, it must hold a 3-lb. load.
- (3) With magnet de-energized, it must hold a 4-lb. load.

d. Beyond a visual inspection for cleanliness, frayed wires and security of attachment, no maintenance should be necessary.

5. INTERVALOMETER. a. Purpose. In order to provide a means for automatic release in train of a number of bombs at a predetermined inter-

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val, measured in feet between successive impacts, the bomb release control (intervalometer) was developed.

b. With the train selector switch in the "train" position, the counter knob requires pre-setting to the number of bombs to be released at least one minute before closing the release switch.

c. Closing the release switch then initiates a train bomb release which continues until the release solenoid circuit has been closed a number of times equal to the original setting of the counter pointer.

d. The pilot light remains lighted, if the jewel rim is in the "on" position only when the counter is set to a position above zero.

e. With the train selective switch in the "selective" position and the jewel rim in the "on" position, the pilot light remains lighted.

f. Turn off. (1) To turn the bomb release control off it is important that the train-selector switch be in the train position, and the counter pointer at zero.

(2) In order to prolong the life of the tubes, and to eliminate inaccurate and erratic bomb releasing impulses, the control should be left off when it is not used.

g. Intervalometer is "off" only when:

(1) Train selector switch is in "train".

(2) Counter-pointer is at "zero".

6. BOMB HOISTS. a. In order to load the heavier type of general purpose bombs, the bomb hoist assembly, Type C-3, was developed.

b. Method of Setting Up Hoist. Information regarding the proper method of setting up the hoist will be found in the bombay of each particular type of plane.

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c. Precautions in Hoisting.

(1) Do not release hoist and remove the sling from the bomb until the hoist cable has been slacked off approximately two inches from the bomb, and security of shackle to the bomb and to the rack has been determined.

(2) When hoisting bombs, it is necessary that the men operating the hoist drums work evenly and smoothly to prevent uneven pulling of cable and bomb sling. This is necessary to prevent rolling of bomb from sling.

(3) The correct size of bomb sling must ALWAYS be used.

(4) The bomb sling must be inspected for condition prior to hoisting (use). This will include frayed straps, loss of cable attaching ends, and general condition.

(5) The hoisting drums and worm drive will in some cases reverse under bomb weight if the hand crank is released.

(6) Bombs must be hoisted and loaded on the racks to match weight tabs at each station.

(7) After use in loading, the cables must have tension applied to them prior to and during rewinding upon hoist drum.

d. Maintenance:

(1) The hoist units will be inspected for such defects as -- frayed cables, loose bolts and nuts, lost or broken cotter pins or safetying, cracked or broken parts.

(2) It is sometimes necessary to periodically clean and grease hoist cables.

(3) It is necessary that hoist units, when stowed, be secured

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secured so as to prevent damage to airplane or hoist units.

7. BOMB SLINGS. a. In order to speed up the loading of heavy bombs (250 to 2000 lbs.) the type A-2 Bomb sling was designed. The sling hook assembly and the locking arm assembly provide the necessary connection between the rollerless chain and the hooks of the two hoist cables.

b. To use sling, the bomb must be clear of the ground (inch or two) so that the sling may be slipped under the bomb and properly located near the center of gravity.

c. During the hoisting operation, the weight of the bomb acts to tighten the sling about the bomb body, thus making slippage impossible.

d. After slings have been used and before repacking them in containers, each unit will be washed in kerosene and then inspected for corrosion, cracks, and bent or broken parts.

e. Any parts found in such condition as to render them inserviceable or questionable in any way will be replaced.

f. No repairs will be made on the type A-2 Bomb Hoist Slings.

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CHAPTER V

COMBAT BOMBING TECHNIQUE

SECTION I - APPROACH WITH C-1 AUTO PILOT

1. GENERAL. a. Procedure outline here based on following premises:

- (1) Bombing run can utilize evasive action.
- (2) Run is short and accurate.
- (3) Target is visible at least 3 minutes prior to bomb release.
- (4) It is possible to make check run when near the target area.

b. Use automatic pilot when in working order.

- (1) Automatic pilot to be used by unit formation leaders.
- (2) Planes to be flown manually on bombing run only as last resort to accomplish mission.
- (3) All turns by manual pilot to be co-ordinated controlled turns.
- (4) Turns using rudder not to be practiced.
- (5) Group leaders to make banks as follows:
  - (a) Not to exceed  $10^{\circ}$  to  $12^{\circ}$  with large formations.
  - (b) Not to exceed  $18^{\circ}$  at any time on run.

c. Evasive action by formation leaders:

- (1) Amount of banks and turns should vary.
- (2) Turns into wind should be greater and longer than turns downwind.
- (3) Turns should avoid drifting downwind from target.
- (4) Bombardier should control evasive action in direction from

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initial point to bomb release.

d. When on manual pilot.

- (1) Pilot follows PDI signals of bombardier.
- (2) Makes co-ordinated turns to center PDI.
- (3) Pilot may change course as directed by bombardier (interphone).

e. When C-1 equipment is used:

- (1) Turns can be made from turn control in bombardier's compartment set to necessary degree of bank.
- (2) Turns can be made by smooth action of secondary clutch on stabilizer.
- (3) Turns can be made by pilot's control.

2. APPROACH FOR EVASIVE ACTION. a. Methods of approach for evasive action at constant altitude prior to initial point.

- (1) Use either E-6B computer or automatic bombing computer.
- (2) Set computer to heading being flown.
- (3) Set in drift, ground speed or tangent of dropping angle and true air speed.
- (4) Determine wind velocity and direction.

b. While ship is straight and level:

- (1) Bombardier unlocks racks.
- (2) Turns selector switch on.
- (3) Sets intervalometer counter-switch to number of bombs desired.
- (4) Set selector to "train".
- (5) Allow intervalometer 1 to 3 minutes to warm up.

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- (6) Bombight stabilizer is leveled.
- (7) Unit leaders adjust auto-pilot.
- (8) Wingman takes same action (as precaution).

c. Initial point to bomb release line:

- (1) Check E-6B or automatic bombing computer.
- (2) Make check of wind direction and velocity.
- (3) Note direction and degrees of turn to hit axis of attack.
- (4) Pre-set drift and tangent of dropping angle.
- (5) Make turn to put ship on heading of final approach (down-

wind).

- (6) Prepare for dry run.
- (7) Open bomb bay doors.

d. Dry run.

- (1) Uncage gyro and unclutch secondary clutch.
- (2) Clutch in directional clutch.
- (3) Make dry run, synchronizing for course, rate.

e. Evasive action:

- (1) Leave gyro uncaged (unless banks exceeding  $15^{\circ}$  are required).
  - (a) Disengage directional clutch.
  - (b) Engage secondary clutch.
- (2) Bombardier directs evasive action:
  - (a) Uses signal to pilot through PDI, or
  - (b) Flies evasive action with turn control or secondary

clutch.

- (c) Directs pilot by interphone.
- (3) If using secondary clutch, move sight and secondary clutch

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smoothly from side to side.

- (4) Do not slip sight independently of secondary clutch.
- (5) Bring PDI to zero.
- (6) Bombardier positions telescope for 20 to 30 second run.
- (7) Do not take vigorous evasive action.
- (8) Turns should be upwind.

f. Check run: (1) Should be made on heading of final approach.

(2) Turn plane with turn control or secondary clutch and sight (as above).

- (3) Place vertical crosshair on target.
- (4) Bring PDI to zero and synchronize.
- (5) Check dropping angle, drift angle, sighting angle for

20 to 30 second run.

g. Evasive action period.

- (1) Continue continuous evasive action until upwind of target.
- (2) Make correction in drift setting, dropping angle and sighting angle.
- (3) Take a straight level run to check sighting angle and establish a level gyro.
- (4) When target appears in top of optic, bombardier brings ship around to axis of attack for final run.
- (5) While changing altitude, use same procedure as above.

h. Unless large amount of altitude is to be lost, change in direction is better evasive tactics.

i. Start evasion by losing 1,000 - 1,500 feet; then evade in

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direction rather than altitude after a check dry run.

j. Evasive action to be taken will vary with the theater of operations.

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## SECTION II

## METHODS OF DETERMINING LENGTH OF RUN

1. BY COMPUTER. a. Figure 5 is designed to find sighting angle of not more than 30 seconds and not less than 20 seconds.

b. On the computer shown in Figure 5, the disc speed set in sight is placed opposite the tangent of dropping angle to be used on bombing run. Sighting angle is then read under lower large arrow. Disc speed is 150 rpm; tangent of dropping angle is 0.5; sighting angle is  $44^{\circ}$ .

c. Figure 6 is designed to find sighting angle of not more than 45 seconds and not less than 30 seconds.

d. Operation of the computer shown in Figure 6 is same as outlined for Figure 5. Disc speed is 150 rpm; Tangent of dropping angle 0.5; sighting angle is  $50^{\circ}$ .

2. BY POSITIONING TELESCOPE. Figure 7 shows a second method of finding sighting angle. If the tangent of the dropping angle has been solved by synchronizing, the rate index is positioned at a definite tangent. The actual time of fall for that altitude is known. Thus from the tangent value indicated on the rate scale to 0 on the rate scale is the ATF. If the tangent value is .40 and the ATF is 40 seconds, then it will take the telescope 10 seconds to travel from .4 to .3 or from .6 to .7, etc., on the tangent scale. Therefore, if the bombardier desires a 30 second run, he has only to count back three tangent values (to .7) and position his telescope.

NOTE: If telescope creeps, turn off telescope motor and clutch in telescope. When cross hairs intersect target, turn on telescope motor.

3. BY TIMING. A third method of positioning the telescope for desired length of run is by timing (trial and error), using a stop watch to time travel

ORDNAMENT DEPT  
APPAT

**TIME-OF-FUN-SIGHTING ANGLE COMPUTER**

1. SET DISC SPEED OPPOSITE TANGENT OF DROPPING ANGLE  
2. READ SIGHTING ANGLE HERE

DISC SPEED

TANGENT OF DROPPING ANGLE

RANGE

SIGHTING ANGLE

**FIGURE 5**

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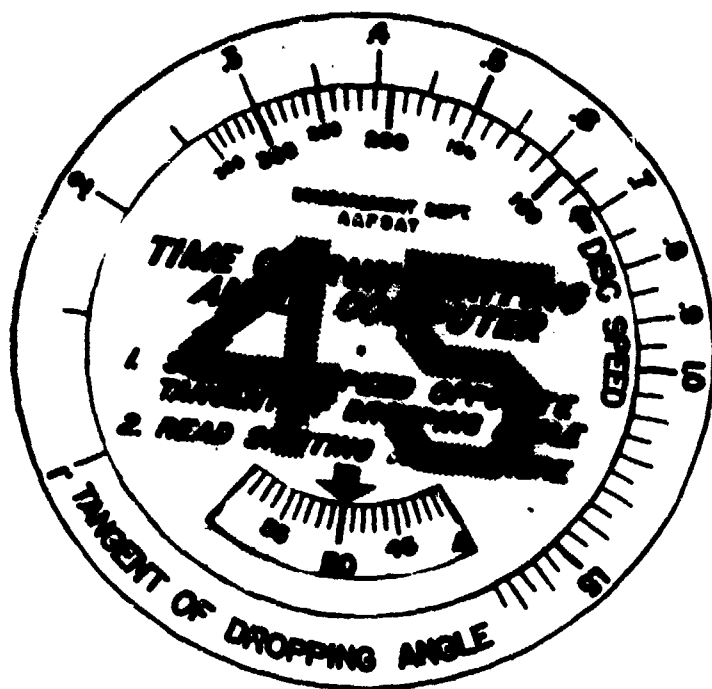
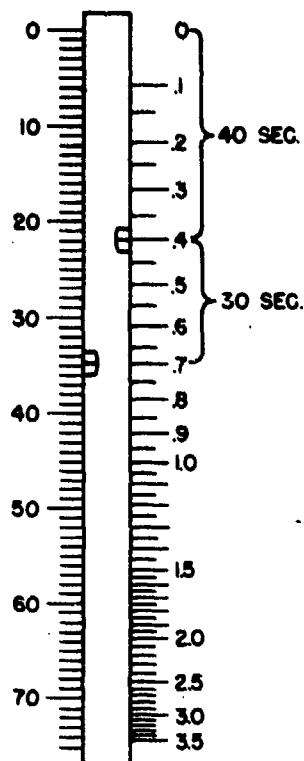


FIGURE 6

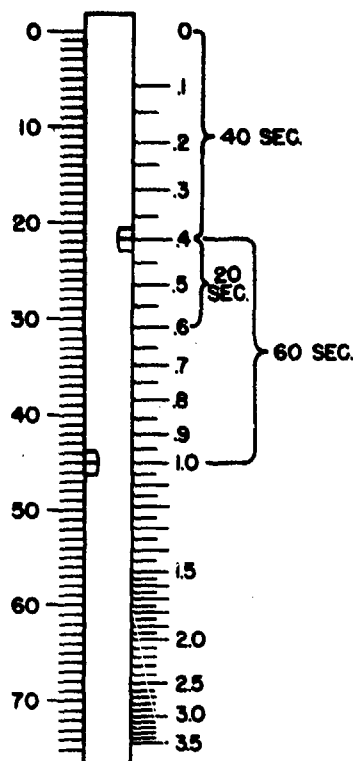
# TIMING OF BOMBING RUN



## EXAMPLE 1.

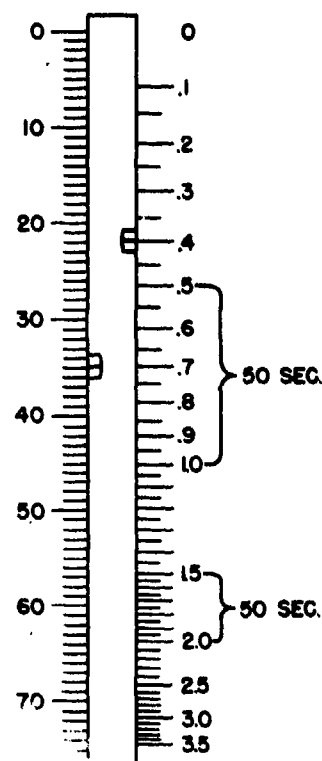
1. ATF 40 SEC.  
RUN DESIRED 30 SEC.  
TAN D/A .4  
TELESCOPE SET .7 (35°)
2. PLACE TELESCOPE INDEX AT .7 OR (35°) WHEN LATERAL CROSS-HAIR REACHES TARGET THERE ARE 30 SECONDS LEFT IN THE BOMBING RUN.  
 $.4 \div 40 = .01$  DISTANCE IN ONE SECOND  
 $.01 \text{ TIMES } 30 = 3$   
 $.4 + 3 = 7$  SETTING

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## EXAMPLE 2.

1. ATF 40 SEC.  
TAN OF D/A .4  
TIME OF TRAVEL PER TAN UNIT = 10 SEC.
2.  $\text{TAN} \div \text{ATF} = \text{DISTANCE OF TELESCOPE INDEX TRAVEL FOR ONE SECOND.}$   
PLACE TELESCOPE INDEX AS FAR BACK AS NECESSARY TO SEE TARGET.  
NOTE NUMBER OF TAN UNITS LEFT BETWEEN RATE AND TELESCOPE INDICES TO TIME LENGTH OF RUN DESIRED.



## EXAMPLE 3.

1. ATF 40 SEC.  
TAN OF D/A .4  
TIME OF TRAVEL OF TELESCOPE INDEX FOR ANY ONE TAN UNIT IS THE SAME.  
BOMBARDIER MAY TIME HIS TELESCOPE INDEX TRAVEL ANYWHERE ON THE SCALE TO DETERMINE LENGTH OF RUN DESIRED.

FIG. 7

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of telescope or by counting (one-thousand-one, etc.). This method is not recommended if other methods can be employed.

4. ALTERNATE METHOD FOR TIMING TURN. a. In the paragraphs above, the bombardier positioned his telescope and, when the target appeared on it, turned on the telescope motor or clutched in the telescope as he came on the course. In doing so, he used his judgment and experience to select the proper time to turn and pick up the target. There is an alternate method for timing the turn so as to be on course at the proper time to assure the desired length of run:

b. The bombardier can clutch in his telescope the first time the target appears in the telescope and leave it clutched in -- telescope driving all the time. He then solves for his sighting angle as in paragraph above and marks the sighting angle position with tape or any other available substance. He may simply note the position. The bombardier can use the rate of closure of his telescope as a guide for timing his turns to assure him of making his last turn at the proper sighting angle. There is also the advantage that the bombardier will have the target in view through his telescope at all times instead of just during the time it appears from the sighting angle to dropping angle.

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CHAPTER VI

NAVIGATIONAL AND BOMBING AIDS

SECTION I - NAVIGATION AIDS -

1. TO OBTAIN DRIFT AND GROUND SPEED WITH M-SERIES SIGHT.
  - a. Turn on stabilizer and sight switches.
  - b. Set in proper disc speed and trail.
  - c. Set telescope at any convenient angle.
  - d. Ship must fly constant heading.
  - e. Uncage sight gyro.
  - f. Swing sight head in direction of drift until vertical hair tracks along objects on ground.
  - g. Engage directional clutch.
  - h. Engage rate clutch and synchronize accurately for rate.
  - i. Read drift on drift scale.
  - j. Read dropping angle and, through use of tables, or computers, derive ground speed.

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SECTION II -

BOMBING AIDS

1. E-6B. a. Following are required. (1) Bombsight mounted in aircraft for normal bombing operation, tachometer and stop watch.

(2) Bombing tables showing the tangents of the dropping angles and the corresponding ground speeds, for type bomb being used

b. To determine true air speed, take pressure altitude from altimeter at 26,000 feet (Figure 8).

(1) Rotate inner disc until it is opposite air temperature aloft ( $-30^{\circ}\text{C}$ ).

(2) Find indicated air speed (155 mph) on minutes scale.

(3) Read off true air speed (240 mph) outer scale.

c. For altitude computations: (1) Repeat same procedure as for TAS, only on altitude scale.

(2) Find indicated altitude on minutes scale.

(3) Read true altitude on outer scale.

d. True air speed and drift. (1) Tangent of dropping angles for corresponding ground speeds and altitudes shown on the E-6B computer (Figure 9).

(2) The pre-arranged E-6B scales are compiled for TDA computed for various altitudes using the same approximate true air speed for all altitudes.

(3) The tables from which these TDA's are derived are shown (Figure 10).

(4) In use, a single drift is taken on any heading.

(5) Then true air speed and drift are known and a wind velo-

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city and direction line determined for any heading.

(6) On the scale, a dropping angle is shown at the end of the wind arrow on the heading to be flown on the run.

e. Drift and Ground Speed. (1) A quite accurate drift can be obtained simply by rotating the bombsight until the vertical hair parallels the object sighted.

(2) For synchronizing for absolute drift, set the trail and disc speed in the sight for the altitude being flown and the bomb to be dropped on that mission.

(3) Turn the bombsight until the proper drift reading has been established, using the sight as a drift meter while the plane maintains a constant heading.

(4) Synchronize for rate.

(5) Using the E-6B (Figure 11).

(a) Place the TAS reading under the center of the transparent disc.

(b) Set the compass heading of the plane opposite the index of the computer.

(c) Plot and mark on the scale where drift and either of the others intersect. This will be the end of the wind arrow.

(6) Wind direction and velocity are obtained by moving the end of the wind arrow until it is directly under the TAS indicator and drawing the mph from the TAS to the wind arrow is the wind velocity and the wind is from the indicated heading (Figure 12).

(7) The wind direction and velocity line will now:

(a) Give the approximate drift and TDA on predicted bomb-



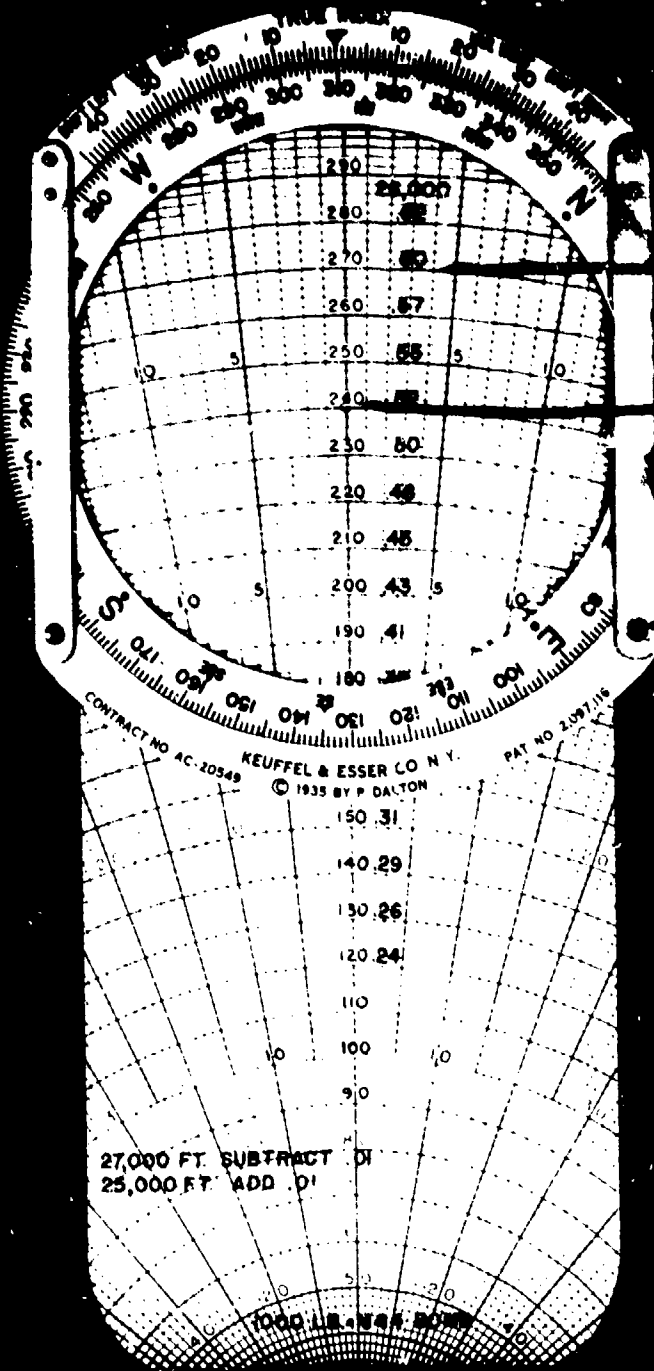


FIG. 9  
TANGENTS OF DROP-  
PING ANGLES FOR AL-  
TITUDES.

TAS = 240 mph

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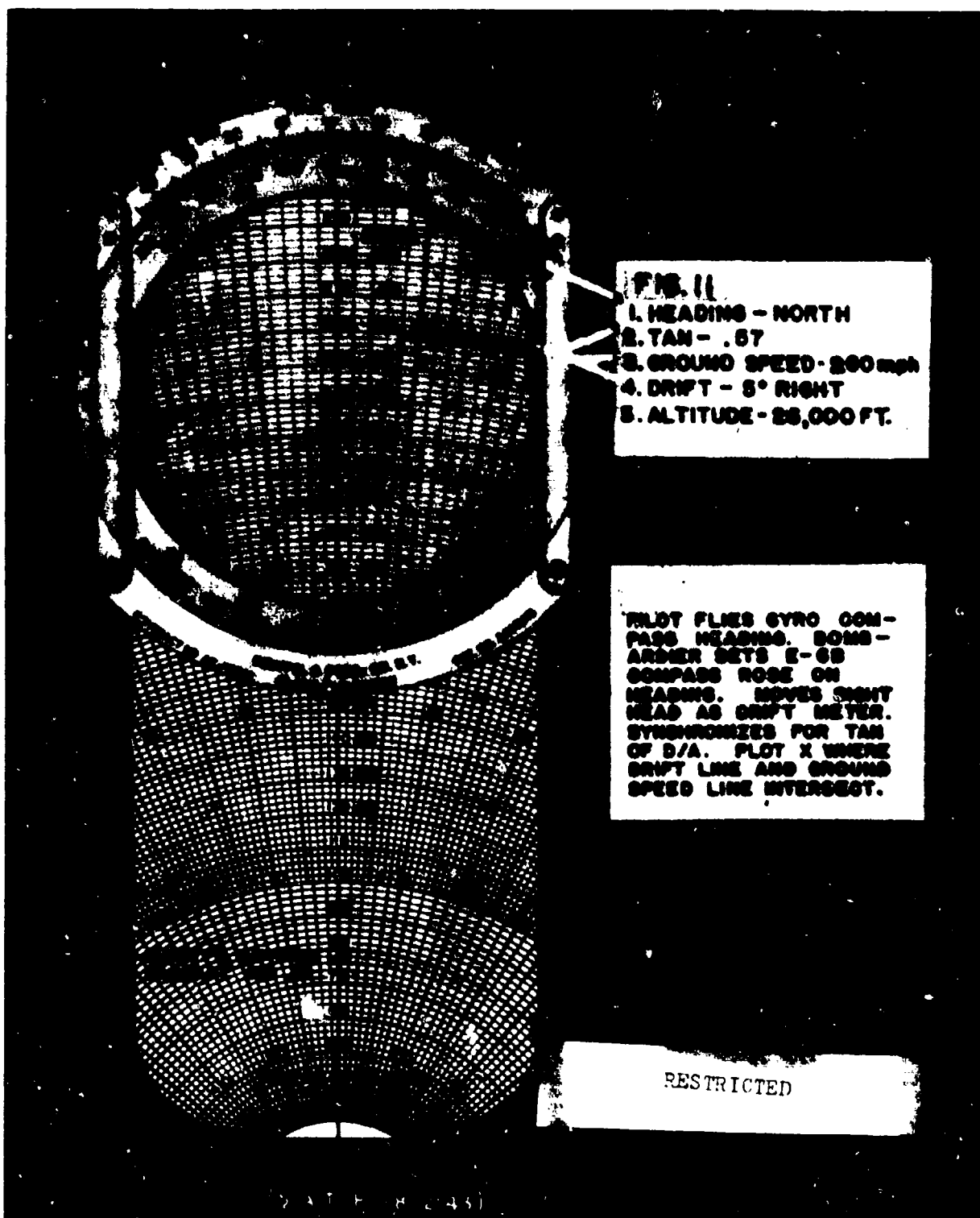
# BOMBS, DEMOLITION, 1000 LB - M4

## TANGENTS OF DROPPING ANGLES

Calibrated Indicated Air Speed 155 m.p.h.

G.S.	Altitude in thousands of feet															
MPH	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
120	.34	.32	.31	.30	.29	.28	.27	.27	.26	.25	.25	.24	.23	.23	.22	.22
130	.37	.35	.34	.33	.32	.31	.30	.29	.29	.28	.27	.26	.26	.25	.24	.24
140	.40	.38	.37	.36	.35	.34	.33	.32	.31	.30	.30	.29	.28	.27	.27	.26
150	.43	.41	.40	.39	.38	.36	.35	.34	.34	.32	.32	.31	.30	.30	.29	.28
160	.46	.44	.43	.41	.40	.39	.38	.37	.36	.35	.34	.33	.33	.32	.31	.31
170	.49	.47	.46	.44	.43	.42	.41	.40	.39	.37	.37	.36	.35	.34	.34	.33
180	.52	.50	.49	.47	.46	.44	.43	.42	.41	.40	.39	.38	.37	.37	.36	.35
190	.55	.53	.52	.50	.48	.47	.46	.44	.44	.42	.42	.41	.40	.39	.38	.37
200	.58	.56	.54	.53	.51	.50	.48	.47	.46	.45	.44	.43	.42	.41	.40	.40
210	.61	.59	.57	.56	.54	.52	.51	.50	.49	.47	.46	.45	.44	.43	.43	.42
220	.64	.62	.60	.58	.57	.55	.54	.52	.51	.50	.49	.48	.47	.46	.45	.44
230	.67	.65	.63	.61	.59	.58	.56	.55	.54	.52	.51	.50	.49	.48	.47	.46
240	.70	.68	.66	.64	.62	.60	.59	.58	.56	.55	.54	.52	.51	.50	.49	.48
250	.73	.71	.69	.67	.65	.63	.62	.60	.59	.57	.56	.55	.54	.53	.52	.51
260	.76	.74	.72	.70	.68	.66	.64	.63	.61	.60	.58	.57	.56	.55	.54	.53
270	.79	.77	.75	.72	.70	.69	.67	.65	.64	.62	.61	.60	.58	.57	.56	.55
280	.83	.80	.78	.75	.73	.71	.69	.68	.66	.65	.63	.62	.61	.60	.58	.57
290	.86	.83	.80	.78	.76	.74	.72	.70	.69	.67	.66	.64	.63	.62	.61	.60
300	.89	.86	.83	.81	.79	.77	.75	.73	.71	.69	.68	.67	.65	.64	.63	.62
310	.92	.89	.86	.84	.81	.79	.77	.76	.74	.72	.71	.69	.68	.66	.65	.64
320	.95	.92	.89	.86	.84	.82	.80	.78	.76	.74	.74	.71	.70	.69	.68	.66
330	.98	.95	.92	.89	.87	.85	.83	.81	.79	.77	.76	.74	.72	.71	.70	.69
340	1.01	.98	.95	.92	.90	.87	.85	.83	.81	.79	.78	.76	.75	.73	.72	.71
350	1.04	1.01	.98	.95	.92	.90	.88	.86	.84	.82	.80	.79	.77	.76	.74	.73
360	1.07	1.04	1.01	.98	.95	.93	.90	.88	.86	.84	.83	.81	.80	.78	.77	.75
370	1.10	1.07	1.04	1.01	.98	.95	.93	.91	.89	.87	.85	.83	.82	.80	.79	.78
380	1.13	1.10	1.07	1.03	1.01	.98	.96	.93	.92	.89	.88	.86	.84	.83	.81	.80
390	1.16	1.13	1.10	1.06	1.03	1.01	.98	.96	.94	.92	.90	.88	.87	.85	.83	.82
400	1.19	1.16	1.12	1.09	1.06	1.03	1.01	.99	.97	.94	.92	.90	.89	.87	.86	.84

Fig. 10





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ing heading, ~~which~~

(b) The wind direction and velocity line will give the drift and TDA for that heading..

(c) Be sure the TDA is read from the correct altitude column.

f. Pre-setting data in sight. (1) The use of this computer provides a quick and efficient method for determining the drift and TDA necessary to the bombardier for pre-setting data in his sight.

(2) Pre-setting is absolutely necessary for a short, 30-second or less bomb run (Figure 13).

g. Before leaving the ground: (1) Bombardier should write all the possible data, such as GS and T which might be used on the bottom of his E-6B..

(2) This is to avoid making mistakes in reading the bombing tables and facilitates work.(Figure 14).

h. When more than  $15^{\circ}$  drift is expected.

(1) The ground speeds on the E-6B may be doubled and

(2) Corresponding tangents computed and written on the computer (Figure 15).

(3) Drift reading remains the same and is not doubled.

2. ABC COMPUTER. a. Zero computer by matching dots on the left, then installing wind gear and compass rose so that dots on the right also match. Set lubber line so that it is opposite wind arrow at the time that the dots are matched and drift pointer is on zero (Figure 16). This step is completed prior to take-off and once adjusted the computer should remain so until removed from the stabilizer. However, it should be checked prior to each

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mission.

b. Select the proper tangent scale and install (Figure 17).

c. Set true air speed (193 mph) on the true airspeed scale (Figure 18). Note, if the true air speed is between 100 and 200 mph, then the scales are used as indicated. If true air speed is above 200 mph, then all the linear scales TAS, G3, and wind are doubled. The dropping angle tangent scale must be selected for the single value of the linear scales or the double value, whichever is used. The speed ranges indicated on the tangent scales show if they are for the indicated scale value or double that value. If one linear scale is doubled, all of them must be doubled; the angular scales (drift) always remain the same and do not double.

d. When ready to determine the wind, which may be done on any straight heading, engage the secondary clutch so that the automatic pilot will fly the ship straight. Set compass rose to magnetic heading ( $160^{\circ}$ ) as obtained from navigators compass and lock to stabilizer gyro with lock for compass rose (Figure 19).

e. Swing sight head as a drift meter to determine drift. When sight is at proper drift angle ( $8^{\circ}$ L) synchronize for the tangent of the dropping angle (.57). This should be accomplished over terrain which is approximately the same elevation as the target.

f. Turn wind arrow on BC to the approximate direction of the wind (from the right in this case).

g. Set drift pointer over drift as determined ( $8^{\circ}$ L) (Figure 20) and then while holding drift in this position rotate wind gear to position ground speed indicator at correct tangent of dropping angle (Figure 21).

h. Clamp wind speed (30 mph) and wind direction (from  $270^{\circ}$ ). This

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entire operation should be accomplished before turning off the heading that the wind is determined on.

i. Now the ABC will indicate the drift and dropping angle for any heading the plane turns to and the wind arrow will indicate the direction of the wind at all times which is useful to the bombardier in planning evasive action. On the bombing run, heading  $66^{\circ}$  the drift is  $3^{\circ}$ R and the tangent of the dropping angle is .62 (Figure 22).

j. If the bombardier wishes to know the drift and dropping angle for some other heading than that on which he is flying, then he loosens compass rose and turns it to desired heading, then resets it to the compass heading on which he is flying after obtaining the information.

k. It should be remembered that the stabilizer gyro on which the compass rose is fastened will be incorrect by about  $10^{\circ}$  for every  $360^{\circ}$  of turn in the same direction, so the compass rose should be re-set to correspond with navigator's compass occasionally when the airplane is flying straight, and should be so set shortly before the turn over the initial point.

3. G-1C. True Air Speed Computer. a. Set pressure altitude (15,000 feet) against calibration indicated air speed in mph on  $V_0$ .

b. Set indicator on air temperature aloft.

c. Read true air speed in mph on  $V_t$  scales under indicator.

d. E-6B may also be used as a true air-speed computer.

4. TYPES C-2 and AN 5837-1: a. Pressure Altitude is the reading of the altimeter after the necessary scale and installation corrections have been applied, when the Kollsman number is 29.92 ( or markers to zero). Since pressure altitude is used in conjunction with the C-2, AN 5837-1, G-1, D-3,

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and E-6B computers, always set the Kollsman number at 29.92 when reading altitude to use with any of these computers.

b. The types C-2 and AN 5837-1 altitude correction computers are designed to apply the necessary temperature corrections to the pressure altitude above the ground to obtain the true altitude above the ground and vice versa. They are intended primarily for use in high altitude bombing photography when the pressure altitude of the ground is not zero, and the mean temperature is known.

c. These computers consist of two concentric discs, a clamping cursor, and a free cursor. The inside small disc carries a pair of spiral scales. The outside large disc carries a pressure altitude scale for setting the pressure altitude of the ground, and a temperature scale for setting the mean temperature of the air in degrees centigrade. The C-2 computer is printed in red and black ink, whereas the AN 5837-1 computer is printed with fluorescent material so that it can be used under ultra-violet illumination. Except for these variations in printing, the two computers are identical, and the following instructions apply to both.

C-2

AN 5837-1

CLAMPING CURSOR .....Black line.....Labeled "PA"

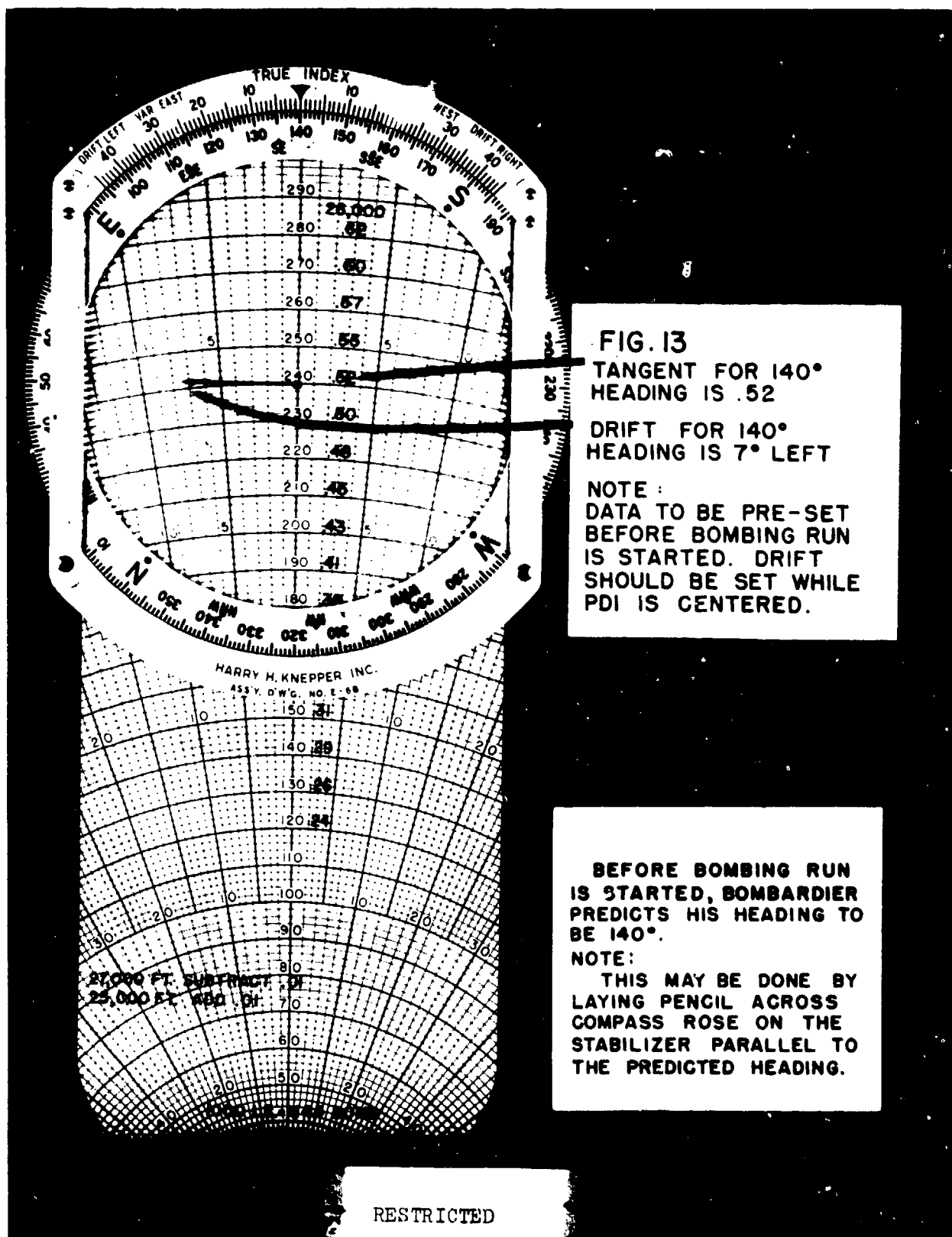
FREE CURSOR.....Red line.....Labeled "°C"

TRUE ALTITUDE.....Red numbers.....White on black background

INDICATED ALTITUDE.....Black numbers.....Black on white background

d. OPERATING INSTRUCTIONS: The types C-2 and AN 5837-1 altitude correction computers will be operated in accordance with the following instructions:

- (1) Before Take-off. Set the clamping cursor (PA) to the pressure



**FIG. 13**

**TANGENT FOR 140°  
HEADING IS .52**

**DRIFT FOR 140°  
HEADING IS 7° LEFT**

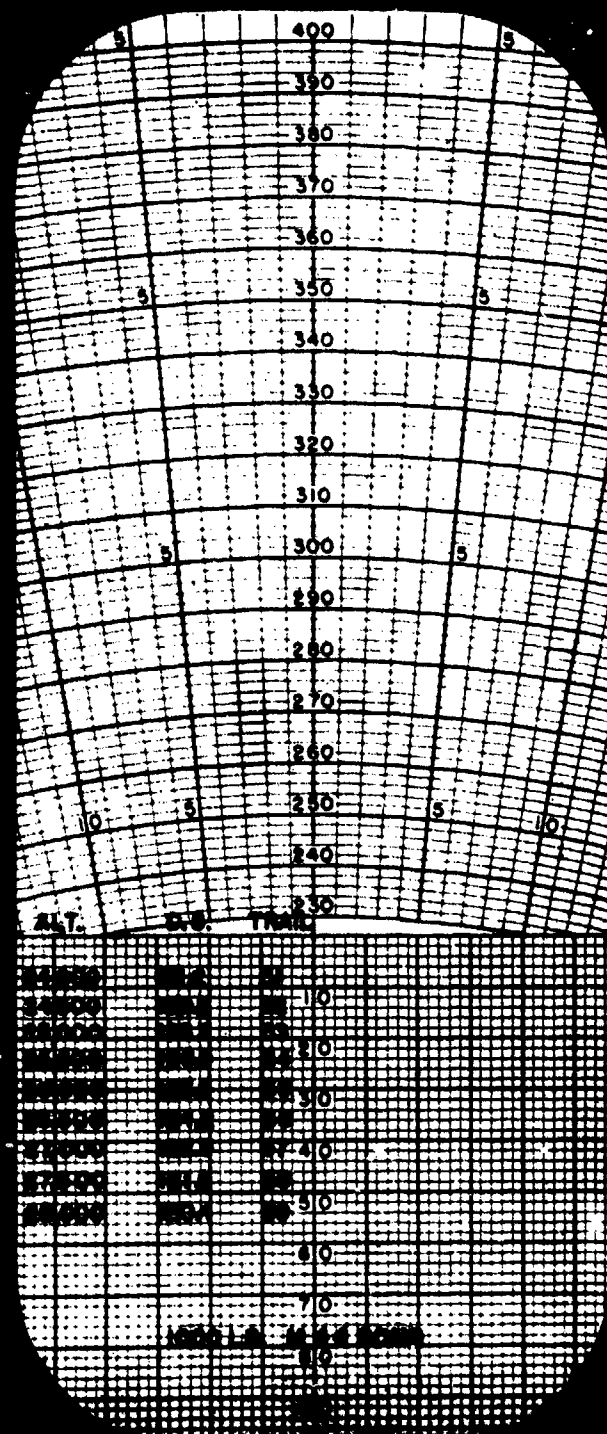
**NOTE :**  
DATA TO BE PRE-SET  
BEFORE BOMBING RUN  
IS STARTED. DRIFT  
SHOULD BE SET WHILE  
PDI IS CENTERED.

**BEFORE BOMBING RUN  
IS STARTED, BOMBARDIER  
PREDICTS HIS HEADING TO  
BE 140°.**

**NOTE:**

**THIS MAY BE DONE BY  
LAYING PENCIL ACROSS  
COMPASS ROSE ON THE  
STABILIZER PARALLEL TO  
THE PREDICTED HEADING.**

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**FIG. 14**

DATA TO BE PUT INTO BOMBSIGHT MAY BE WRITTEN ON E-6-B COMPUTER WHILE ON THE GROUND TO AVOID MISTAKES CAUSED BY THUMBING THROUGH TABLES WHILE IN THE AIR.

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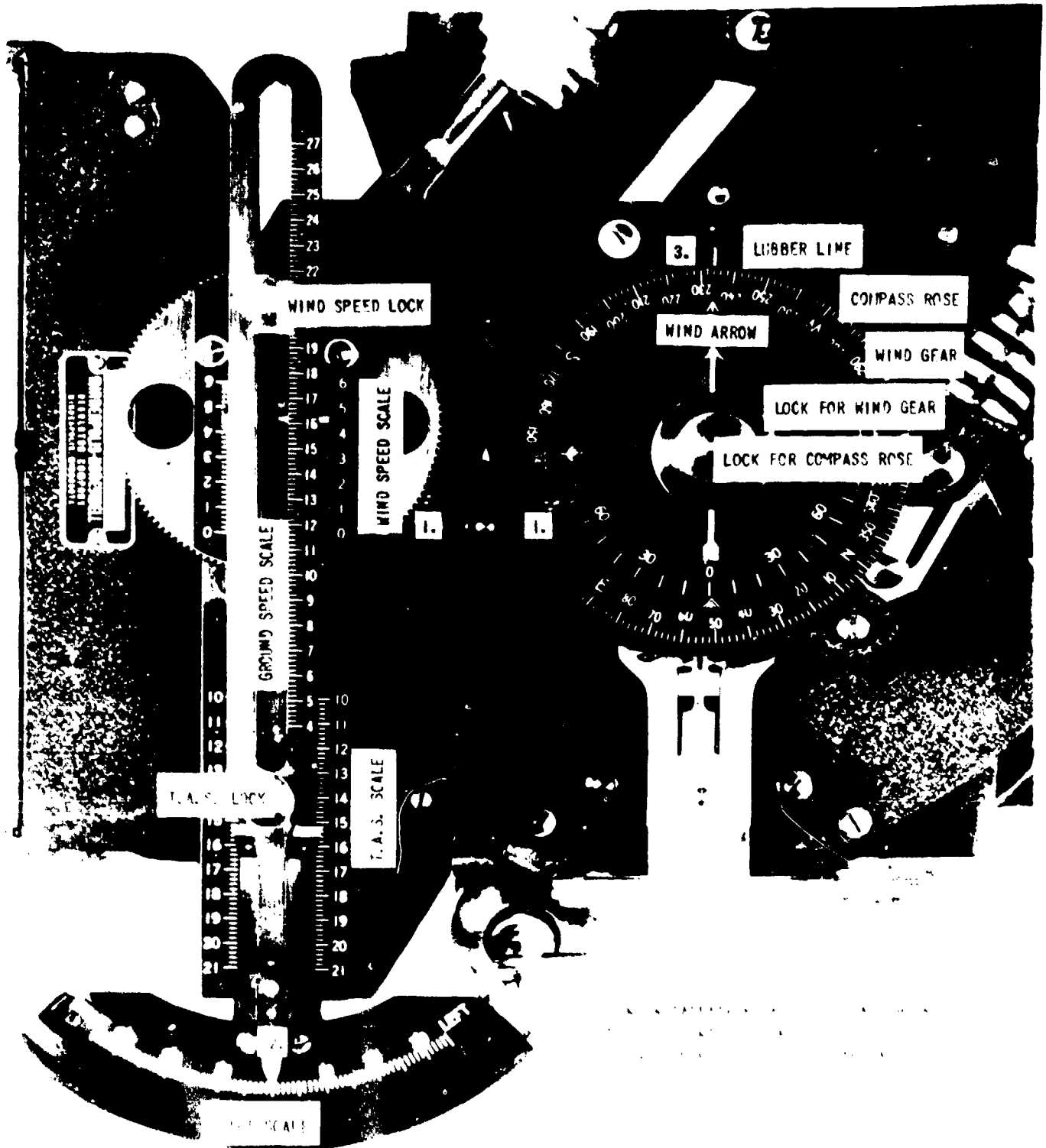


FIGURE 1. Automatic Wind Speed Indicator

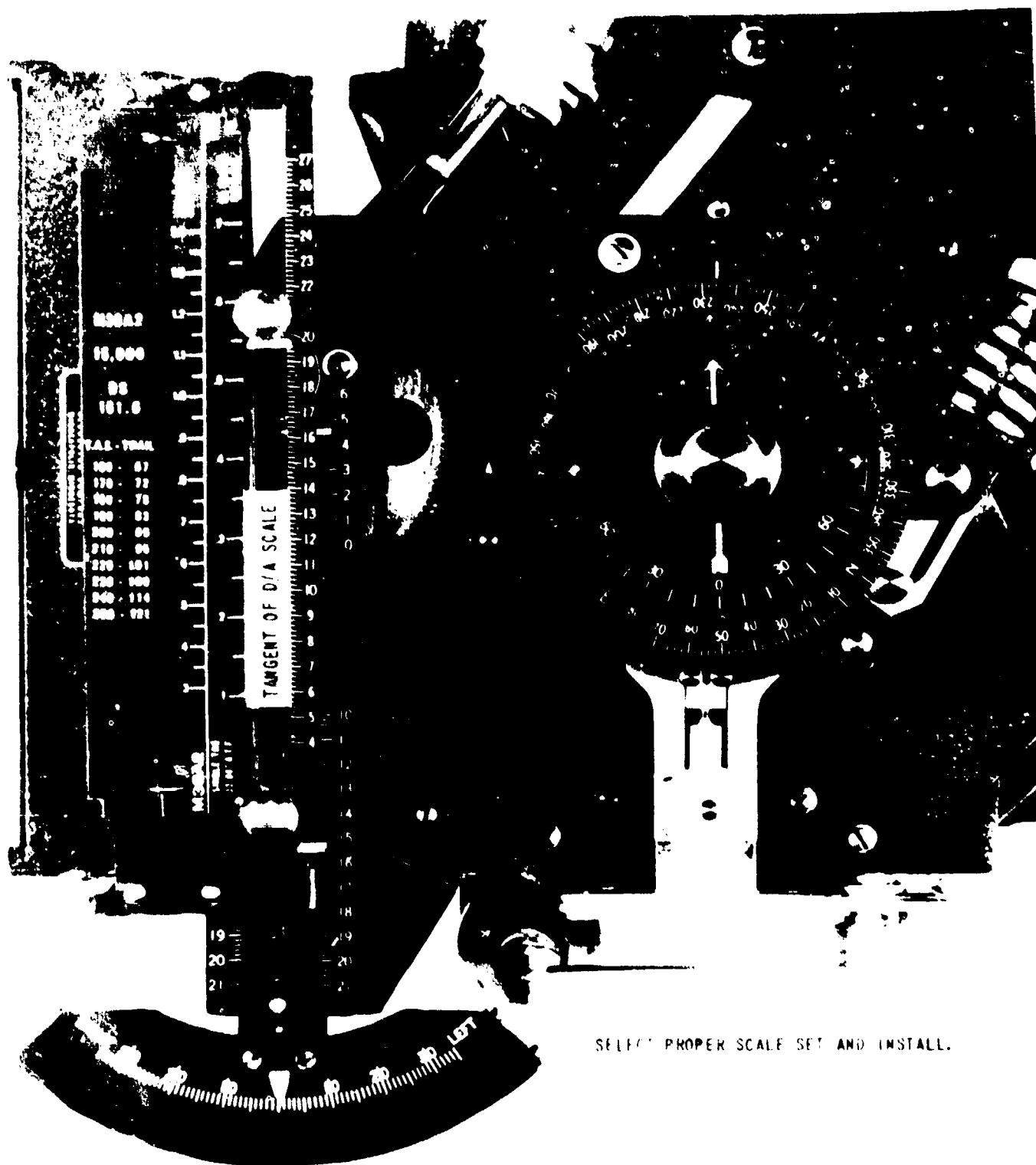


Figure 17 Automatic Bombing Computer

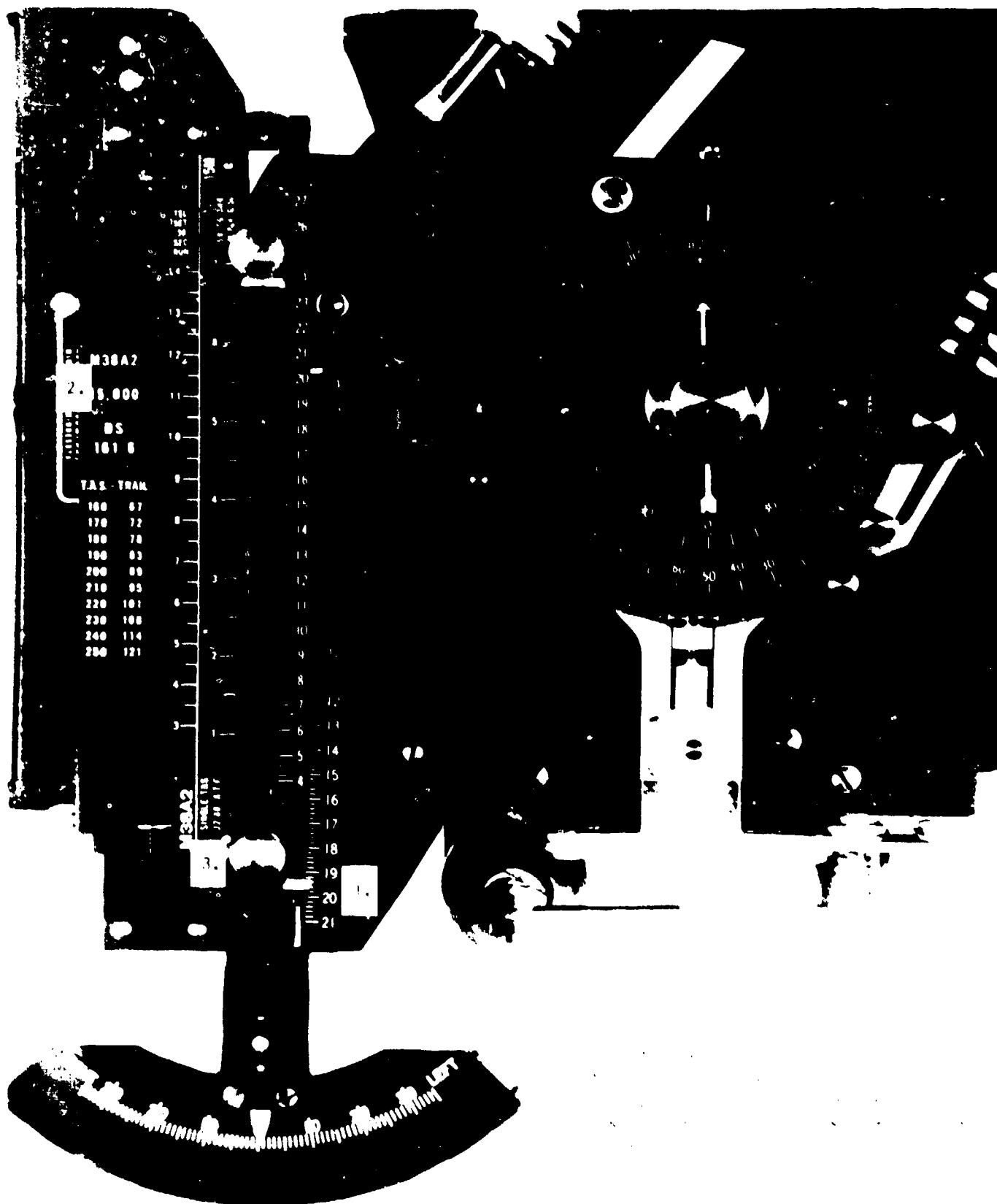
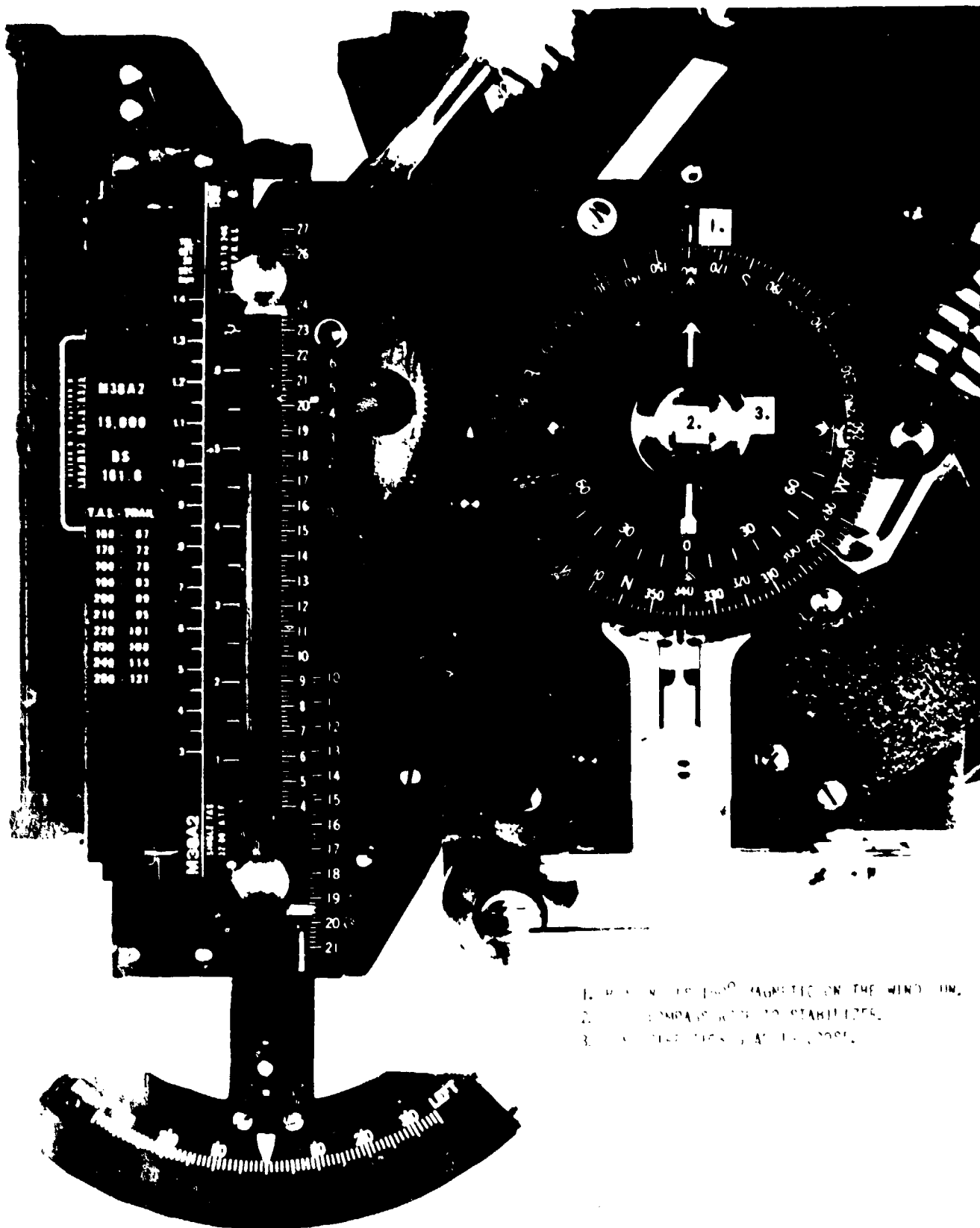


FIGURE 1

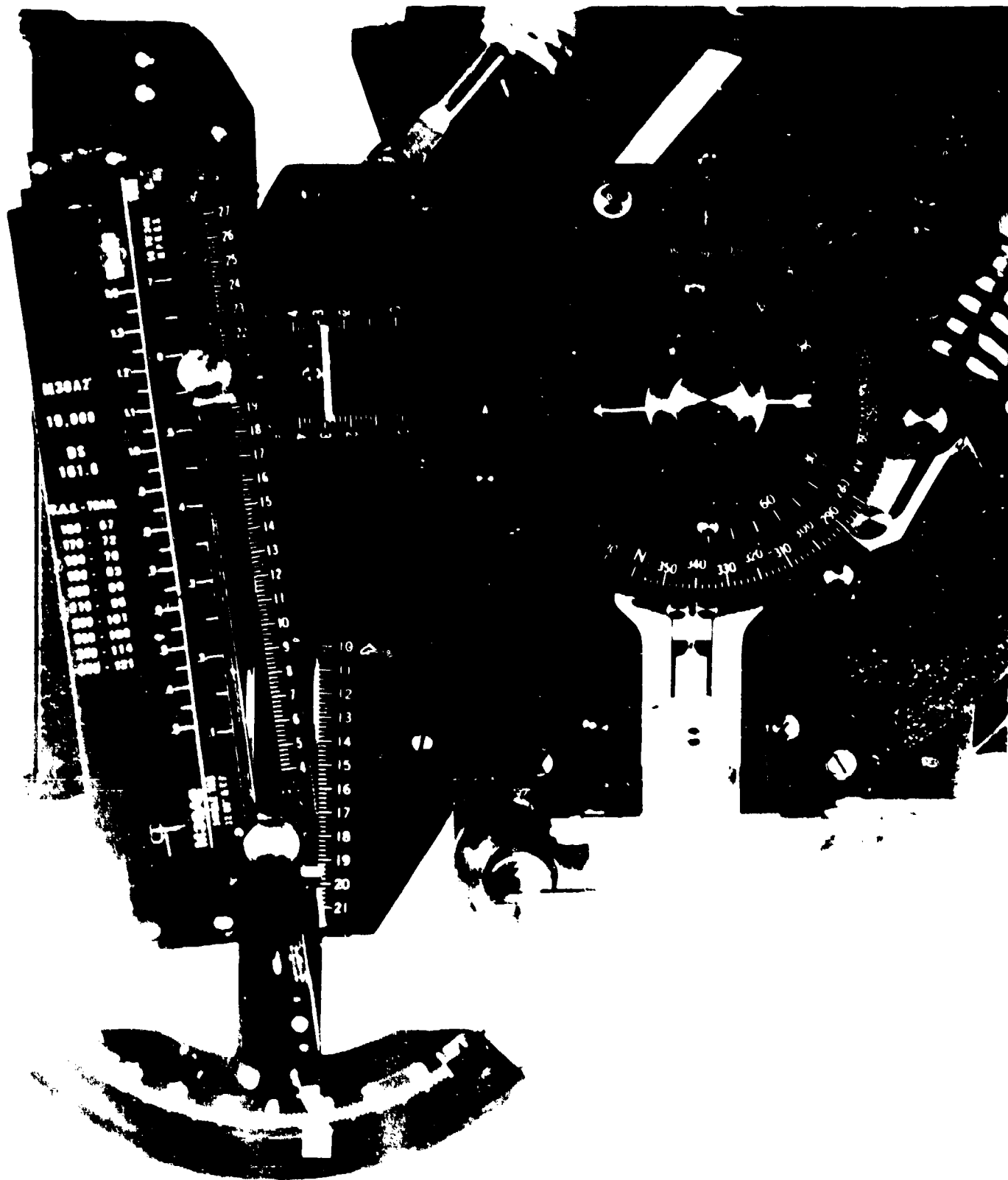
RESTRICTED

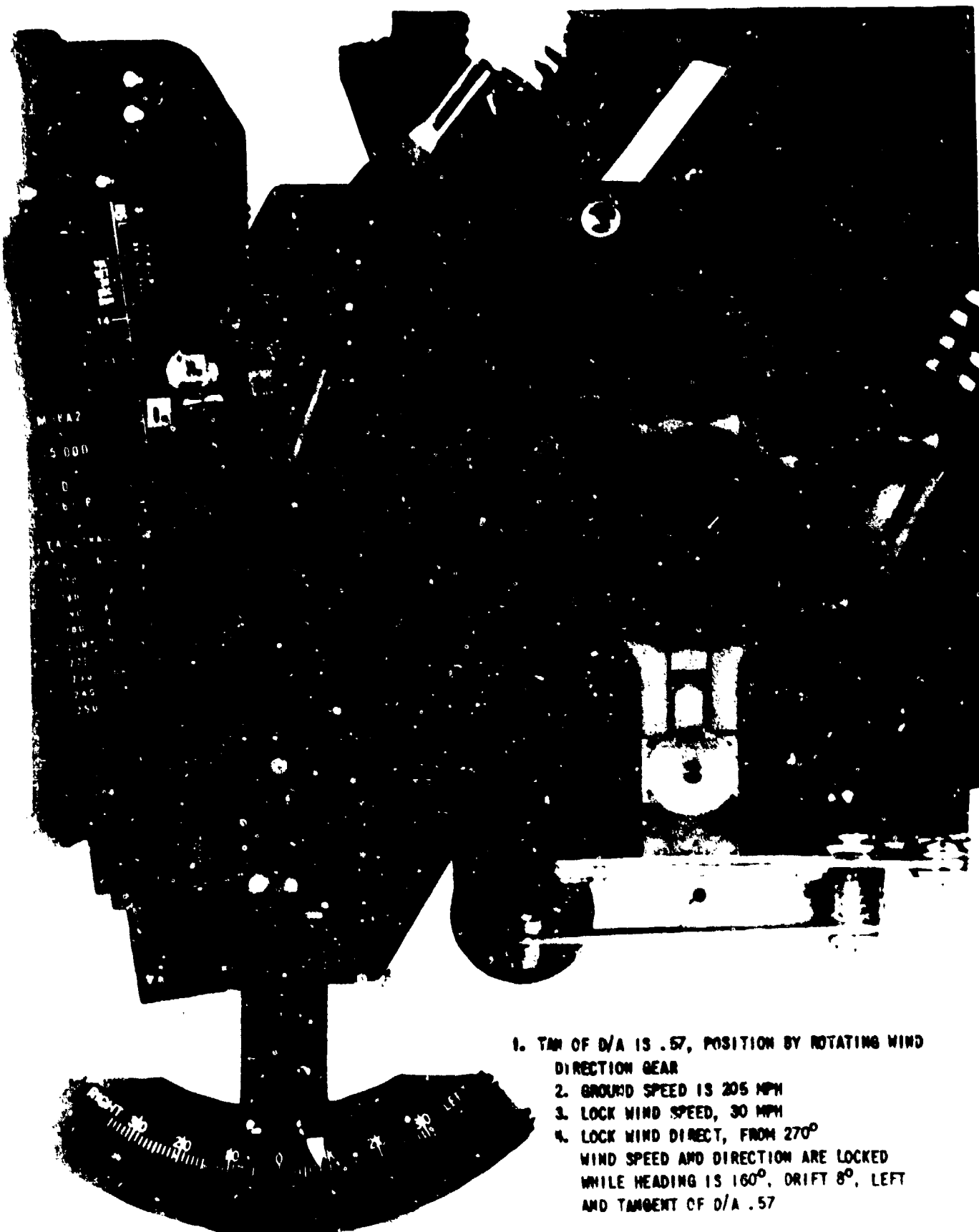




1. MAGNETIC ON THE WIND.
2. COMPASS WITH TO STABILIZER.
3. MAGNETIC ON THE WIND.

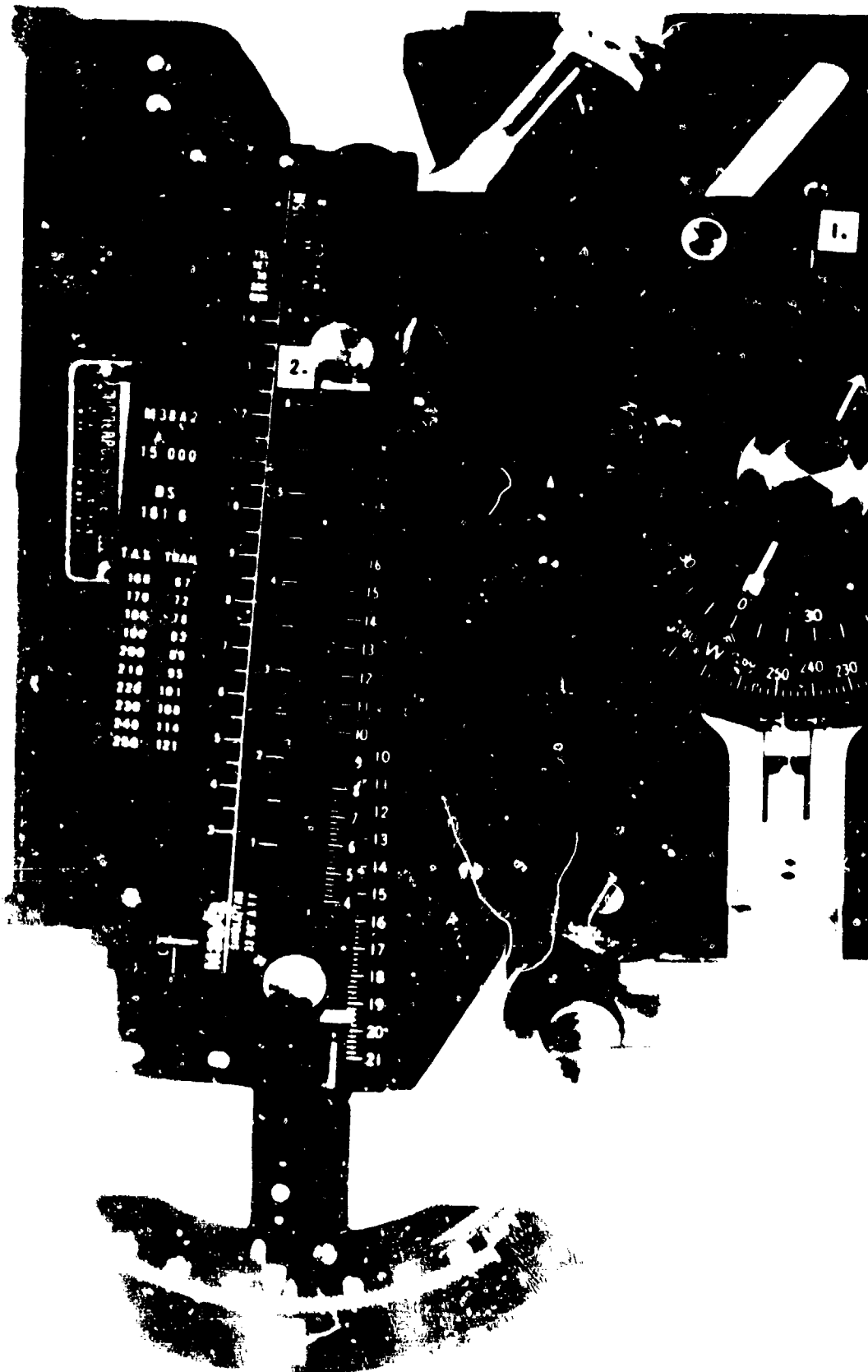
Figure 19 - Automatic Bombing Computer





1. TAN OF D/A IS .57, POSITION BY ROTATING WIND DIRECTION GEAR
2. GROUND SPEED IS 205 MPH
3. LOCK WIND SPEED, 30 MPH
4. LOCK WIND DIRECT, FROM 270°  
WIND SPEED AND DIRECTION ARE LOCKED WHILE HEADING IS 160°, DRIFT 8°, LEFT AND TANGENT OF D/A .57

Figure 21 - Automatic Bombing Computer



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altitude of the target and look in position. If the weather officer is unable to estimate the pressure altitude of a target, then use the true elevation of the target above sea-level.

(2) Set the free cursor to the average temperature of the air over target:  $\text{average temperature} = \frac{(\text{temperature at target}) + (\text{temperature aloft})}{2}$ .

(3) The black number under the black-line (clamping or PA) cursor is the pressure altitude above the pressure altitude of the target. That is,

Black Number = PA (aloft) - PA (of target).

(4) The red number under the red-line (free or °C) cursor is the true altitude of the airplane above the target. Always follow along the line of graduations from one cursor to the other.

(5) The mean temperature involved here is strictly not an ordinary arithmetical mean, but rather the arithmetical mean of temperatures taken at very particular altitudes, such as those shown on the Bombing Flight Record, Form 12-C, used in the bombing schools. Since in combat the determination of such a mean temperature in the vicinity of the target would usually be impossible, the mean temperature to be used will have to be the average of the temperature aloft and the temperature on the ground, estimated if necessary.

(6) Pressure variation at target is the plus or minus expression of the difference between the actual and the the sea-level barometric pressure reading at the target. This variation is then applied to true elevations of target to derive pressure altitude of target.

(7) Temperature aloft must be corrected by use of calibration

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cards for compression errors according to airspeed and for instrumental errors in thermometer.

## c. EXAMPLE:

- (1) To find true altitude above the target.

### GIVEN:

Estimated pressure altitude  
of target: 2,500 feet  
Estimated ground temperature of target:  $+14^{\circ}\text{C}$   
Pressure altitude aloft: 21,200 feet  
Corrected temperature aloft:  $-20^{\circ}\text{C}$

### (2) SOLUTION:

- (a) Lock clamping cursor on 2,500 (PA of target) on pressure altitude scale.
- (b) Set free cursor on mean temperature:  
$$\frac{14-20}{2} = \frac{-6}{2} = -3.$$
- (c) Set PA aloft minus PA of target ( $21,200 - 2,500 = 18,700$ ) on INDICATED ALTITUDE scale (black numbers) under clamped cursor (black line).
- (d) Read 19,100 on TRUE ALTITUDE scale under free cursor (red under red). This is the True Altitude above the target.

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BOMBARDIERS' C-2 WORK SHEET

- |   |   |
|---|---|
| 1. Set Altimeter  | 29.92   |
| 2. True Elevation of Target                                     | .....   |
| 3. Pressure Variation at Target                                 | .....   |
| 4. Pressure Altitude of Target (Add step 2 to step 3)           | Black<br><div style="border: 1px solid black; width: 50px; height: 20px; margin: 2px 0;"></div> |
| 5. Estimated Target Temperature                                 | .....   |
| 6. Corrected Temperature Aloft                                  | .....   |
| 7. Mean Temperature (add step 5 to step 6 and divide by 2)      | Red<br><div style="border: 1px solid black; width: 50px; height: 20px; margin: 2px 0;"></div>   |
| 8. Pressure Altitude Aloft                                      | .....   |
| 9. Pressure Altitude Above Target (Subtract Step 4 from Step 8) | Black<br><div style="border: 1px solid black; width: 50px; height: 20px; margin: 2px 0;"></div> |
| 10. True Altitude Above Target                                  | Red<br><div style="border: 1px solid black; width: 50px; height: 20px; margin: 2px 0;"></div>   |

Figure 23.

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CHAPTER SEVEN

GROUP BOMBARDIER BRIEFING  
PROBLEM

SECTION I

BOMBARDIER'S COMBAT GUIDE

1. GENERAL. a. Bombardier must be thoroughly briefed.  
b. Must make thorough pre-flight inspection.
2. BRIEFING. a. Crew must be able to visualize target and approaches before taking off.  
b. Bombardier must know objective folder:
  - (1) Should study available pictures.
  - (2) Should study maps.
  - (3) Should study axes of attack.c. Other briefing information:
  - (1) Indicated altitude on bombing run.
  - (2) Elevation of target.
  - (3) Altimeter setting to be used.
  - (4) Indicated airspeed to be used on bomb run.
  - (5) Bomb load, type and fusing.
  - (6) Temperature and pressure at target.
  - (7) Information on alternate targets.
  - (8) Weather data.
  - (9) Aiming point.d. From metro data, find the following:
  - (1) Ground speed (with use of E-6B computer). Example:

Wind Velocity	30 mph
Direction	230° true

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Temperature	-26° C	This data gives
Altitude	28,000 ft.	true ground speed
I.A.S.	175 mph	of 260 mph.

Figure 24.

- (2) Tangent of Dropping angle (Figure 25).
  - (3) Magnetic heading of bombing run (downwind):
    - (a) To insure minimum drift.
    - (b) To insure maximum ground speed.
3. DURING THE MISSION. a. Bombardier observes enemy territory.
- (1) Uses field glasses.
  - (2) Locates check points to help find targets.
  - (3) Check points very helpful when target is camouflaged.
- b. Prior to "Bombs Away".
- (1) Bombardier takes over formation 30 miles from target.
  - (2) Guides flight in.
  - (3) Checks controls, racks, switches prior to release.
  - (4) Checks pre-set data on the A.B.C.
  - (5) Starts evasive action to reach point at which bombing run starts.
  - (6) Bomb bay doors opened at initial point.
- c. After "Bombs Away":
- (1) Bombardier observes target closely.
  - (2) Checks time over target.
  - (3) Checks results of bomb hits.
  - (4) Notes drift and tangent.
  - (5) Notes number and type enemy fighters encountered.

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- (6) Notes flak and type of fire used.
- (7) Notes ground batteries.
- (8) Notes enemy surface activities.
- (9) Notes weather closely.

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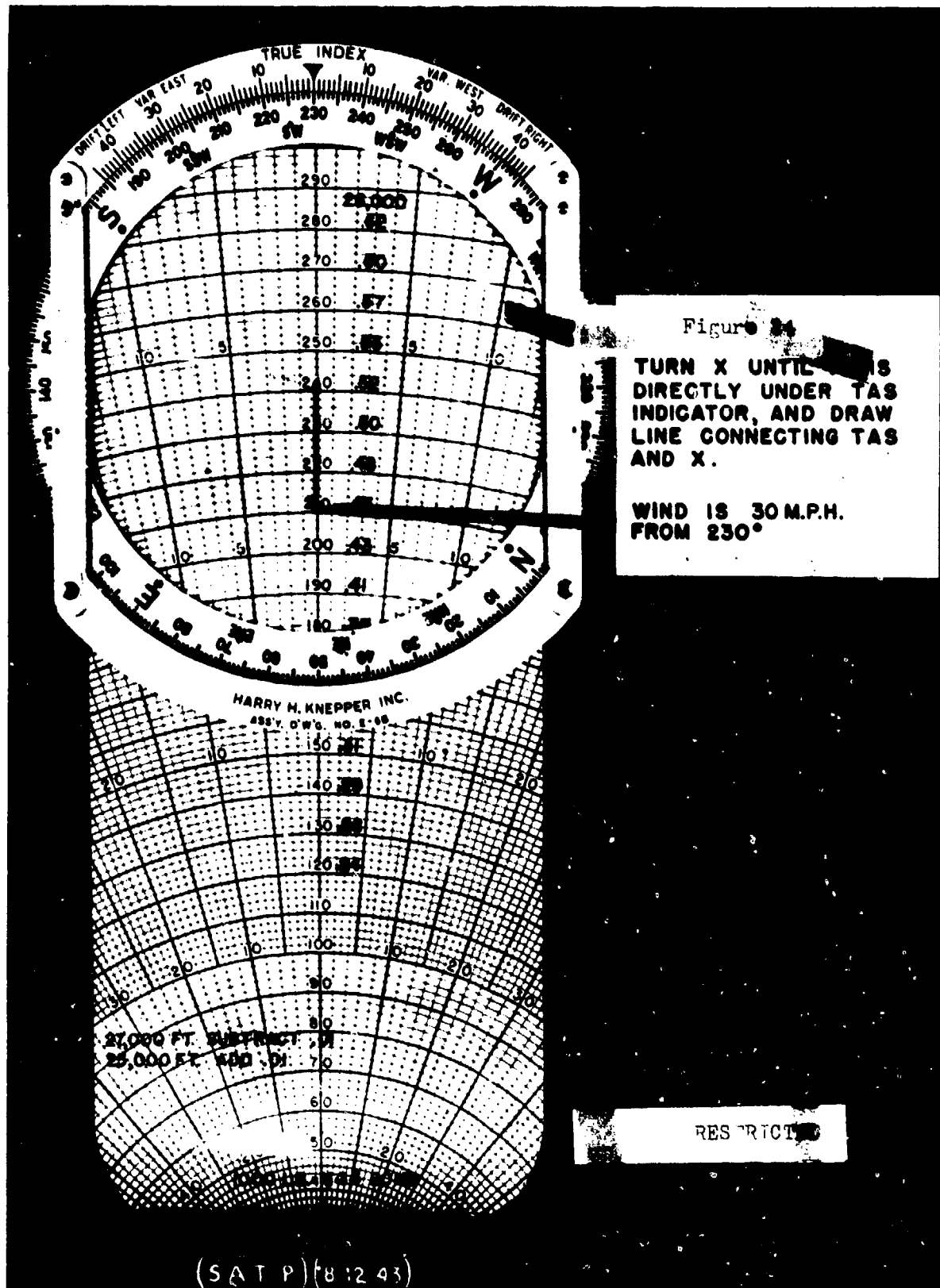
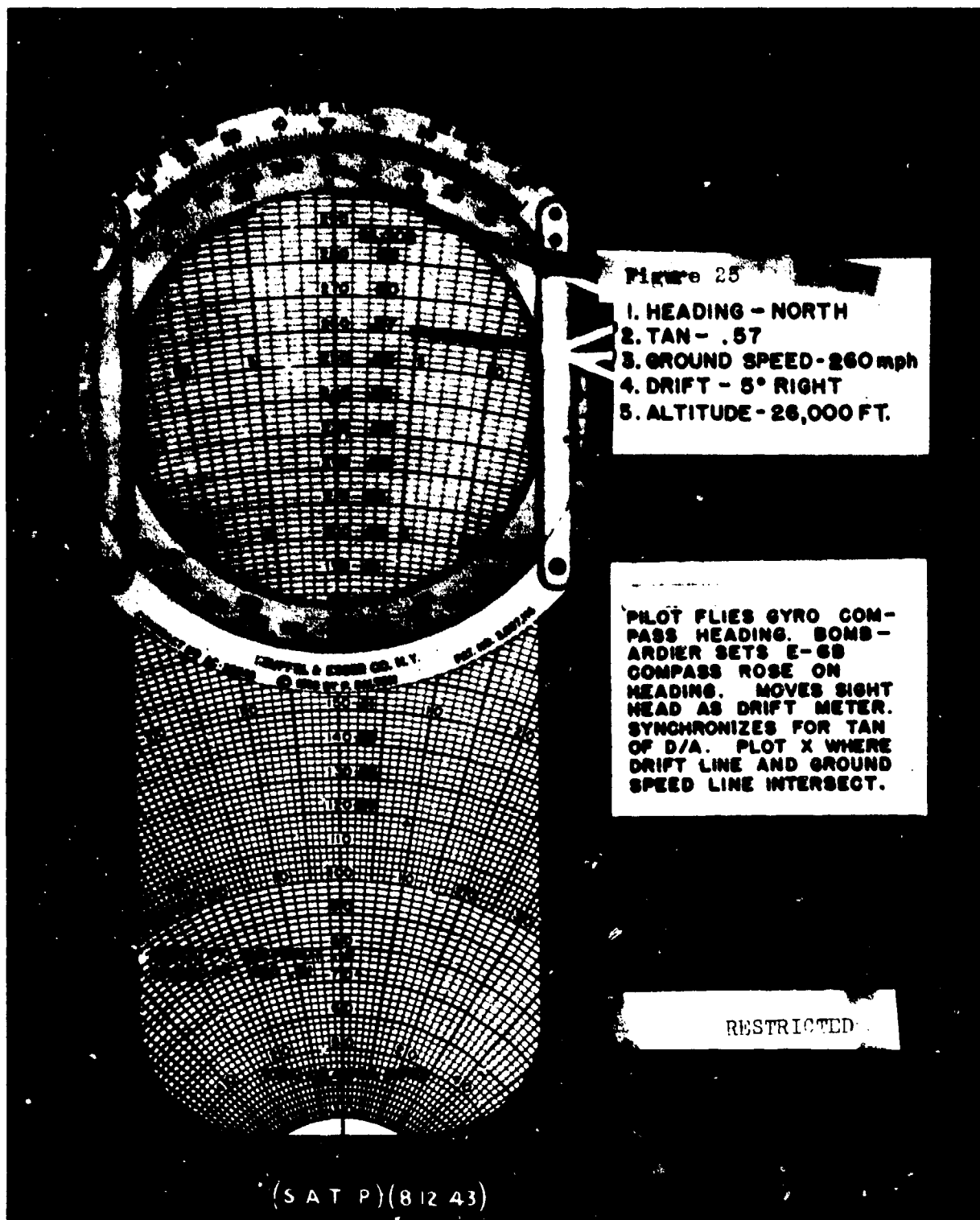


Figure 24

TURN X UNTIL IS  
DIRECTLY UNDER TAS  
INDICATOR, AND DRAW  
LINE CONNECTING TAS  
AND X.

WIND IS 30 M.P.H.  
FROM 230°



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SECTION II

TARGET IDENTIFICATION

1. INTRODUCTION.
  - a. Lead bombardier may cause success or failure.
  - b. Lead bombardier must identify target quickly.
  - c. Lead bombardier must know objective folder thoroughly.
  - d. Lead bombardier must beware enemy ruses.
2. CHARTS AND PHOTOS.
  - a. Small scale chart of the city pinpoints possible objectives in that area.
    - b. Large scale chart of the actual objective area pinpoints every possible objective.
    - c. Others are perspective charts used as identification aids.
    - d. Vertical photos of target area are used.
    - e. Oblique photos of target also help to present target as it appears to bombardier.
3. GERMAN CAMOUFLAGE.
  - a. Use of decoy targets.
    - (1) Dummy and decoy installations.
    - (2) Camouflage in original construction.
  - b. Decoys effective against night bombing.
4. USE OF FIELD GLASSES.
  - a. Necessary to practice on dry run.
  - b. Target is usually picked up more quickly with field glasses than with bombsight.
5. CONCLUSION. Success of mission depends on ability of bombardier to recognize target.

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## CHAPTER EIGHT

## ADVANCED TACTICS

## SECTION I

## GLIDE BOMBING ATTACHMENT MK.2

1. GENERAL. a. The GBA is an auxiliary instrument for use with the Norden bombsight. It replaces the telescope motor and automatically drives the disc at the correct speed for the altitude being flown.

b. The automatic disc speed control tends to improve horizontal bombing accuracy. Thus, the pilot can concentrate on keeping the air speed correct, because any variation in altitude is compensated for by the GBA. A more important feature is that it makes possible accurate bombing in a glide or climb.

2. USE OF GBA. a. Installation. (1) Remove standard tachometer connection assembly from rate end of bombsight and replace with one furnished with GBA.

(2) Enlarge the four holes on rear of stabilizer and tap for No. 8-32 screws. Fasten GBA in place with the four screws provided. Some airplane installations will require a separate mounting for the GBA.

(3) Connect flexible shaft from the GBA to the bombsight, taking care that splined fittings are properly meshed and the holding nuts are tight.

(4) Connect the static tube to the GBA. (Static line is part of plane installation.)

(5) Connect GBA plug to a 26-volt power supply.

b. Pre-Flight. (1) Put disc speed change lever in neutral.

(2) Rate motor switch off.

(3) Rate indicator not on zero.

(4) Telescope clutch disengaged.

(5) Turn on GBA and allow it to warm up and set pressure altitude.

(6) Note that VH (rate of descent in ft/sec) scale is on zero or oscillating about  $\pm 4$  ft/sec.

(7) Pull out altitude knob and turn until altitude scale reads zero.

(8) Turn GBA off.

c. Horizontal Bombing. (1) At altitude set true altitude above target on GBA altitude scale.

(2) Set correction on disc speed correction knob.

(3) Set trail in the usual manner on bombsight trail arm.

(4) Bombing run is made in the normal manner, except that rate motor is turned off and the speed change lever is neutral.

d. Glide Bombing. (1) Estimate true altitude of release.

(2) Set in disc speed correction.

(3) Set the trail arm to trail for the estimated air speed and altitude of release.

(4) Using the indicated altitude the ship is flying, apply the pressure temperature correction (with E-6B) for the estimated true altitude of release.

(5) From figure derived in step four, subtract true altitude of target, and set the result on GBA altitude scale.

(6) Bombing run is made as before except that synchronization is only correct for the instant. Therefore, it will be necessary to adjust rate continuously until the bomb has been released.

(7) Release must occur between 4,000 and 20,000 feet.

(8) In using GBA for glide bombing the point at which to start bombing run, air speed, vertical rate of descent, and altitude of release must be estimated.

3. DIRECTIONS FOR COMPUTING GBA DISC SPEED CORRECTIONS FOR ANY BOMB.

- a. Find value of disc speed in vacuum at bombing altitude.
- b. Find value of disc speed in air for specific bomb being dropped.
- c. Find difference between these two disc speeds.
- d. Set this disc speed correction on GBA.

VACUUM DISC SPEED FOR ANY BOMB:

Altitude	VDS	Altitude	VDS
4000	336.0	13000	186.4
5000	300.6	14000	179.6
6000	274.3	15000	173.5
7000	254.1	16000	167.7
8000	237.6	17000	162.9
9000	223.6	18000	158.8
10000	212.5	19000	154.2
11000	202.6	20000	150.2
12000	193.9		

FIGURE 26.



## SECTION II

## HIGH ALTITUDE BOMBING OF MANEUVERING TARGETS

1. SIGHTING TECHNIQUE. a. The present types of bombsights in use are designed for synchronous bombing on stationary targets, while in combat areas a large percentage of the bombing must be done on maneuvering ships. Evasive action of these targets consists of changes of speed and direction. Consequently, to insure any degree of success, it is necessary to develop a sighting technique which can help compensate for the inadequacies of our present sights.

b. In using the M-Series ~~bombsights~~ sightings on maneuvering vessels, there are two factors which increase the bombing errors. These are:

(1) The target can change speed and course after the bombs leave the plane, and can thus be quite far from the hypothetical position set up by the sight during the run.

(2) The sight cannot be synchronized on a maneuvering target, because the dropping angle and the course are not constant.

2. NEED FOR NEW TECHNIQUE. a. Little can be done to remove the difficulties of the first factor, but an intelligent study of the turn the target is making, just prior to release, will help.

b. There is, however, a new technique which can aid greatly in eliminating the difficulties caused by the second factor.

3. RANGE. a. First, ground speed should be determined before the bombing run is started. This should be used to set up a dropping angle. When synchronization for rate begins, every change on the rate knobs must be done by double gripping.

b. A constantly changing dropping angle is the only solution for a constantly changing rate of closure, and this can be accomplished only by double

gripping of the rate knobs.

4. DEFLECTION.a. The major problem for the bombardier on a target using evasive action is deflection. Changes in rate can be compensated for by the bombsight alone, but changes in course involve the airplane in the air in relation to the target. The amount of changes in course, and the number of such changes, which can be accomplished during one bombing run, are limited.

b. The first step is to reduce to a minimum the number of turns which will be indicated on the PDI, in order to avoid corrections in course which will prove incorrect and which must be taken out later in the run; and to limit the intensity of these corrections, so that they may be accomplished by the pilot.

c. There is no infallible method of setting up a bombing course on a maneuvering target, but there is one procedure which will minimize the difficulties. This consists of pre-setting the drift.

d. The other drift factor, which cannot be pre-determined, is the movement of the target ship itself.

(1) Bombing run should be short.

(2) Follow the target for most of run, using outside knob only.

(3) Near end of run, check direction of target motion carefully.

(4) If the target is making good a course within 20 degrees parallel to that which the plane is making, use the outside turn and telescope displacement knob to off-set the cross-hairs inside the direction of turn.

5. STUDYING THE SHIP'S COURSE. a. If target's course is more nearly perpendicular to that of the plane and shows no indication of becoming parallel to it, it will be necessary to change the plane's course radically and quickly. This can be accomplished by quick use of the inside course knob and violent correction by the pilot.

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b. In connection with this type of correction, several factors must be kept in mind by the bombardier:

(1) If a target is making good a course nearly perpendicular to that of the plane 10 or 15 seconds before bomb release, and if the target continues to turn, its course would probably be almost the same as that of the plane by the time the bombs hit the water. In this case a large drift correction would not be desirable.

(2) The bombardier must avoid making radical changes too far from bomb release. This would cause an incorrect change, and ruin the bombing run. It should be remembered that a sizeable correction in course can be made even in the last five seconds of the run. The later the bombardier makes this last change, the better are his chances of hitting the target.

(3) It is never advisable to try to outguess the enemy, if such a guess involves displacing the aiming point more than half the ship's length.

(4) There should be no hesitation about having the pilot put in course corrections up to the time of bomb release. The fact that the plane is turning at the time of release does not "throw the bomb out". The bomb will leave the plane along a path which is tangent to the curve the plane is making good. Thus, if the plane is turning in the direction of the target, the point of impact will be nearer the target than if no correction were being made.

6. PLAN III, as shown in Figure 27, has been proven superior to individual, pattern, or any other type of formation, in successfully attacking maneuvering targets.

CHAPTER IX.

MISCELLANEOUS

SECTION I.

DESTRUCTION OF CONFIDENTIAL EQUIPMENT

1. GENERAL. a. All bombardment personnel will carry .45 calibre automatic pistols in flight.  
b. Bombardier is responsible for destroying confidential equipment.
2. DESTROYING THE M-SERIES BOMBSIGHT. a. Bombardier fires two pistol rounds into rate and mechanism.  
b. Bombardier fires one pistol round through telescope.  
c. Removes bombsight and throws overboard.
3. WHEN PISTOL IS NOT AVAILABLE. M-Series sight is thrown overboard.
4. WHEN BOMBARDIER IS CASUALTY. Some other member will perform the destruction.
5. DESTRUCTION OF ENTIRE PLANE a. Use incendiary grenade, type AN-M14.  
b. Crew member at nearest station operates grenade.  
c. Alternate crew member selected to operate grenade.  
d. If advisable, crew may open gas tank, drain and fire plane.

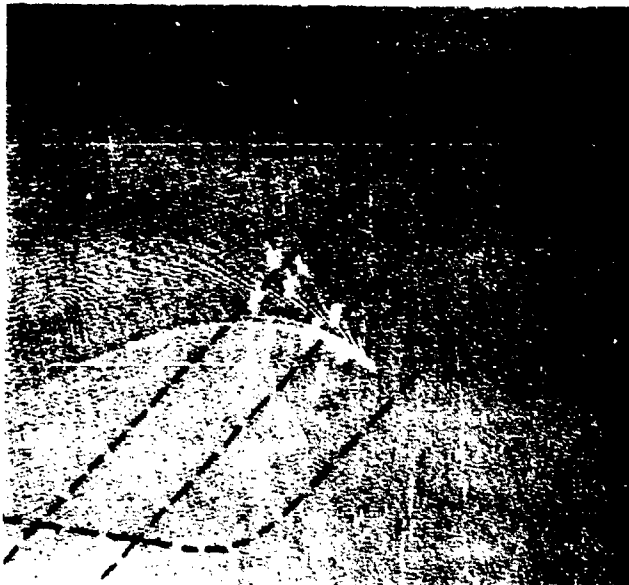
R E S T R I C T E D

**PLAN I.**

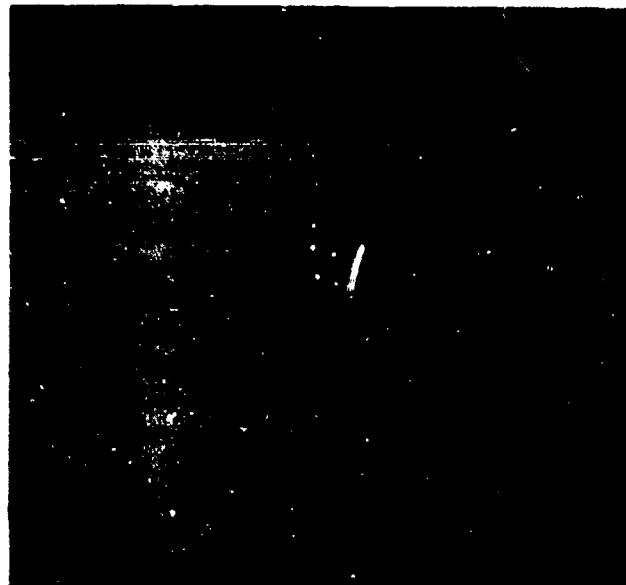
Plan I, in which all nine planes bomb on the leader, with one sighting operation for the 36 bombs, is not considered very effective. The pattern is good, but the lead bombardier has no reference point in which to lay that pattern.

**PLAN II.**

Plan II, is the second best method. The first two flights have dropped bombs and made a hit. The target boat has passed the point of contact as result of the time delay in taking the sighting. The bombs of the third flight have not yet hit the water.

**PLAN III.**

Plan III is recommended. The first two flights have made hits on the target. The bombs of the third flight have not yet hit the water.

**PLAN IV.**

Plan IV indicates that coverage that would have been afforded by a right wing man might have resulted in hits. This plan is not recommended.

Figure 27

RESTRICTED

SECTION II.

THE RADIO TELEGRAPH CODE

A . -	I ..	Q --.-	Y -. -	5 .....
B - ...	J .---	R .-. .	Z --..	6 -....
C ---	K -. -	S ...	Numericals, Punctuation Marks, etc.	7 ---...
D - ..	L .-..	T -		8 ---..
E .	M -	U ..-	1 .---	9 ---.
F .. - .	N -. .	V ---	2 ..-	0 ---
G - .	O -	W .-	3 ---	
H ....	P .-.	X -.-	4 .-.-	

SOS .....-...

Period .. . . .

Comma .-.-.-

Question  
Mark .-.-..

Quotation  
Mark .-.-.-

Exclama-  
tion -.-.-

Colon ---...

Semi-  
colon -.-.-.

Paren-  
thesis -.-.-.

Fraction  
Bar -.-.-.

Wait.  
Sign .-....

Break -....-

End of  
Message .-.-.

Erase .....

End of  
Trans-  
mission .-.-.-

Code Groupings:

E	.
I	..
S	...
H	....
5	.....
T	-
M	---
O	----
CH	-----
O	-----
A	-.-
U	.-.-
V	.-.-.
4	.-.-.-
N	-.-.
G	.-.-.
9	.-.-.-



# DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE OHIO

MEMORANDUM FOR HQ AFMC/HO

ATTENTION: DR. WILLIAM ELLIOTT

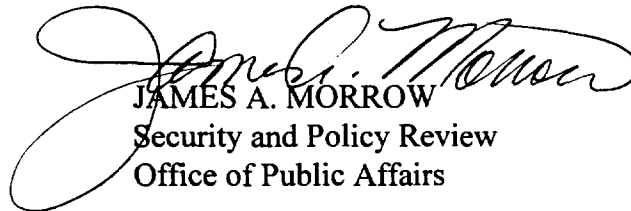
FROM: HQ AFMC/PAX

5 MAY 2000

SUBJECT: Security and Policy Review, Case AFMC 95-276

1. The reports listed in Attachment 1 were reviewed for security and policy IAW AFI 35-205 (now AFI 35-101), and were cleared for public release. According to our logs, the material was reviewed by HQ AFMC/PA and by SAF/PAS. It was our case number AFMC 95-276, and Air Staff's number SAF/PAS 95-0995. It was cleared for public release 22 Nov 95. All the material is releasable to the public, without restriction.

2. If you have any questions or comments, please call me at 77828. Thanks.

  
JAMES A. MORROW  
Security and Policy Review  
Office of Public Affairs

Attachment:

1. HQ AFMC/HO Ltr 12 Oct 95

10/13